André B. Dorsman · Volkan Ş. Ediger
Mehmet Baha Karan *Editors*

Energy Economy, Finance and Geostrategy

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Foreword

The utilization, exploitation and control of energy resources are topics of immense geostrategic importance to most industrialized nations. Energy resources and low electric prices are the key to economic development, growth and prosperity. Many of the modern political and military conflicts are in countries located close to the regions with hydrocarbon-based energy resources. Terrorism, extremism, proliferation of mass destruction weapons and political refugee waves have increased the threats and political tensions in these regions.

Major hydrocarbon resources discovered or about to be discovered under the sea in the Eastern part of the Mediterranean Sea have spurred political tensions, frictions and anxiety in an already volatile region. The discoveries have attracted the interest of large oil companies that have been investing heavily in the exploration and discovery of hydrocarbon reservoirs and their economic exploitation. The involved countries attempt to maximize their economic and political benefits through the formation of strategic alliances and partnerships. The southern energy corridor passing through Turkey is a viable alternative that could potentially benefit all countries involved. However, the exploitation of the hydrocarbon resources in Eastern Mediterranean Sea, to the fullest extent, requires overcoming and solving numerous political challenges and problems.

Climate change, the costs associated with CO_2 pollution emissions and phasing out nuclear power plants have made many countries, including the European Union (EU), to search for alternative energy sources, such as green and renewable energy. Specifically, the EU climate policy requires substantial decrease of fossil fuel consumption and production during the coming years. Research evidence, presented in this book, suggests that green energy projects are less profitable than non-green energy projects and, therefore, have a negative impact on firm values. Moreover, they are likely to result in volatile electricity prices. It appears that in the immediate future fossil fuel, coal and oil, gradually will be substituted mainly by natural gas, which is less harmful to the environment.

Other topics of great interest include the deregulation and liberalization of the natural gas and energy sectors aiming at greater efficiency in distribution and production and lower prices for the consumers. There are cases, however, where deregulation led to underinvestment and higher prices. The dynamic relationship among crude oil prices and prices of basic petrochemical byproducts, such as naphtha, benzene, ethylene, propylene, acrylonitrile and vinyl chloride polymer, is quite an interesting issue for oil producing countries and petrochemical companies alike, as well as policymakers. Uncovering such relationships enables companies and countries to use petrochemical goods as hedging instruments against oil price falls. Last but not least, major oil and gas producers faced the challenges of declining consumption on the demand side; as consumers turned to alternative energies, energy efficiency improved, and non-Organization of Petroleum Exporting Countries (OPEC) oil supplies increased.

This book includes 12 well-written chapters interlinking energy economics, finance and geostrategy. The book covers in an informative and scientific manner many of the aforementioned topics and issues. I find the book quite interesting and relevant to scientist and policymakers interested in energy economics, finance and geostrategy.

Cyprus University of Technology
Limasol, Cyprus
January 2018

Panayiotis Theodossiou

Contents

Introduction: Energy Economics, Finance, and Geostrategy

1

André Dorsman, Volkan Ş. Ediger, and Mehmet Baha Karan

Abstract

Since countries' economic independence is based on energy security, decisions on energy economy and financing are assessed mainly by geostrategic considerations. Economically optimal decisions are not enough regarding geostrategy. This situation makes it difficult to make decisions in energy markets, and it creates considerable controversy. The role of financial markets is to measure the risk of this complex structure or energy projects and price them in financial basis. Understanding behavior of energy markets, it is necessary to look at them on an event basis. The limited availability and unequal distribution of energy sources and different pricing and cost mechanism of energy supplies are hardening to arrive a simple solution. Therefore, the research articles of this book are aimed to open new perspectives for the reader and researchers.

Keywords

Energy economy · Finance · Geostrategy

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1.1 Introduction

Aiming to cultivate the closely interconnected fields of energy and value including their relations to the disciplines of economics, finance, management, technology, and law, Center for Energy and Value Issues (CEVI) introduces the sixth book with this publication. The sixth CEVI book focuses on research articles on three timely concepts; energy economics, finance, and geostrategy. During the last decades, these concepts have been intertwined and formed an essential part of the energy arguments in the field of energy amongst practitioners, financial experts, economists, and academics. Notably, in the multi-polar world that has begun to emerge in recent decades, it is not possible for the energy economy to be independent of financial markets and geostrategic evaluations. From the planning of huge energy projects to investments at company level, all market players have to take these new developments into account.

As it will be underlined in the several sections of this book, decision-makers usually regard energy security as a priority. The natural gas pipeline projects, which are recently planned or in construction, are very good examples, showing the importance of security issues. The feasibility of transporting energy resources to the European markets from the Middle East, Central Asia, and the Eastern Mediterranean can only be explained by geopolitics or geostrategy beyond economics. Likewise, the speculation about the Nord Stream and Turkish Stream projects that are planned to transfer Russian natural gas to European markets are usually caused by such reasons. Today, financial markets give increasing emphasis on energy security and political risks beyond economic criteria. Moreover, economic and political risks are monitored with a variety of financial indices and markets react instantly to any changes in geopolitical risks.

We believe that a book containing energy markets, finance, and geostrategic issues will not only attract readers but also will inspire them for the further studies. There are 12 new research papers in the book, the writers have put forward original ideas and findings within the framework of their views and research. The second section of the study will describe the trends in the energy economy. In the third section of this chapter, the role of finance in the energy sector will be explained. In the fourth section of this work, the geostrategic vision of energy economy will be discussed. In the fifth section, the sections of the book will be presented in detail, and then the paper will be finalized with the conclusion section.

1.2 Trends in the Energy Economy

Energy economy has now become one of the principal branches of the modern economy that encompasses the use of energy resources by people and its consequences. The concept of energy economy was first used in the literature on the consumption of coal in the mid-1800s, and it entered into the economy literature after the 1973 oil crisis. Since then, not only the economic aspects of main energy sources such as oil, natural gas, coal, and renewables but also the environmental issues related with them have been examined by energy economists in detail. Until the end of last century, the energy economy mainly dealt with coal and oil and their economies, however, after the rise of the green economy concept, energy economists' interest has expanded into the nuclear and renewable energy. After the natural gas industry has undergone a significant transformation, with the discovery of shale gas, the energy economists have started to analyze the effects of the shale gas boom on the world market, particularly to the Middle East and Russia.

Energy economists are usually interested in investigating and examining the most cost-effective energy source for different consumption areas. Moreover, in last two decades, the monopolistic structure of energy markets has been evolving into more competitive structures. The developments in the European Union and the USA are noteworthy in this regard, and significant reforms are also being carried out in many developing countries such as Brazil, Argentina, and Turkey. With these changes in the markets, energy economists began to examine not only the relationship between economic variables and energy products but also the price movements of various energy sources. As the relationship between these issues has been better understood, energy production, distribution, and consumption activities have become more efficient.

One of the important areas of study of economists has recently been a transition to green economy. This new concept includes the examination of environmental factors and modelling of environmental impacts of energy production, transportation, and use. The national policies of the European Union and many other countries towards lowering greenhouse gas emissions, pollution, and fossil fuel dependence has been reflected in the energy economy publications since the beginning of the 2000s. The public sensitivity to environmental issues brought the energy sustainability concept to top of agenda. Sustainable energy systems that are defined as serve "meeting the needs of the present without compromising the ability of future generations to meet their own needs" became a new focus area of the energy economists. Due to increasing cost of energy to the societies, energy efficiency policies are becoming a crucial part of the global energy market and researchers of energy efficiency. Studies of energy economies are not limited to macro-level researches, but also cover micro level investigations including sectors, companies and even consumers.

Finance of energy projects and corporations constitutes an important part of the micro energy economy. In the past, energy financing was largely based on project funding, but now energy markets and business financing have become important, and energy economists have been increasingly interested in micro-level research. On the other hand, access to secure and convenient sources of energy has become necessary to the functioning of modern economies. However, the unbalanced dispersion of energy sources among countries has led to significant problems. Today, due to increasing energy security threats in the world, geopolitics and geostrategy have been started to be linked with energy economy studies.

1.3 Role of Finance in Energy Sector

According to the International Energy Agency (IEA), the total global energy investments reached USD1.7 million, corresponding to 2.2% of world GDP in 2016 (IEA 2017). While the electricity sector received the most significant share

(USD718 million), the total oil and gas investments amounted to USD649 million. On the other hand, energy efficiency investments on a global basis reached to $232 million, 5% more than the previous year. The investments on electricity generation from renewable sources, which have been increasing in the last decade, also have a considerable share with USD297 million.

Undoubtedly most of these investments have been realized with project financing. Since the energy projects are usually large and have high returns, they are very important for both national and international finance sectors. The most significant difference between project financing and other types of financing is that the investors see the project assets as collateral, rather than the cash flow from the project. Assessing and pricing of risk is a fundamental component of project financing, and especially the energy investment projects are subject to some technical, economic and geopolitical risks. Therefore, most of the researches on financing energy investments focus on these variables.

As energy companies have become increasingly competitive in recent years, research on financial management has also increased. In addition to the investment and financing activities of companies, financial management is also interested in the efficient use of their assets. While energy companies are concerned with the management of their current assets ranging from cash management to inventory management, the area of capital budgeting is also important for financial management. The capital structure decision of the energy companies, the calculation of the debt and equity costs and the selection type of financing are also the responsibility of the financial management.

Technological, environmental, economic, and geostrategic factors determine the new structure of international energy markets. The European Union is the leader in market restructuring, integration of national markets, internalization of environmental costs, and the introduction of new technologies (Vasconcelos 2009; Karan and Kazdagli 2011). Especially since 2000, energy markets have developed substantially due to the growing activity of financial investors. Thus, by removing the obstacle between energy investments and the finance sector, every sector in society has been investing in the energy-related projects. Moreover, financial innovations and derivative financial instruments have created new sources to energy investors and made energy market more competitive than before. As the energy markets have been integrated into the financial markets, finance researchers have continued to examine the energy industry more deeply. The most significant task of financial markets is to evaluate the risks of this complex structure (or energy projects) and price or value them on a monetary basis. Eventually, all financial activities including project financing, the management of financial sources and investments of energy companies, security and commodity markets have become an integral part of the energy economy.

1.4 Geostrategic Vision of Energy Economy

The geostrategy, which deals with the combination of geopolitical and strategic factors has become a global concept with the ever-increasing importance of energy sources after the World War I. However, the widespread use of geostrategy in energy economy has only begun after the 1973 oil crisis, which was a widely accepted bottleneck in the supply of petroleum to the world economy (Isswi 1978). The 1973 oil crisis not only slowed down the global economic development but also one of the underlying reasons behind the conflicts emerged as a result of geopolitical rivalry in the Middle East. Following the 1973 crisis, the United States abruptly lost its energy independence, speculative finance has risen, and the neoliberal ideology reshaped global trade relationships (Smith-Nonini 2016). Inevitably, most of the researchers on energy economics have begun to include geostrategic and geopolitical interpretations in their studies.

Another major oil shock began with Iraq's occupation of Kuwait in 1990. The United States' rapid intervention contributed to reducing the potential risk of future oil supplies, thereby calming the market and restoring global confidence. The Gulf War of 1991 and also the dissemination Soviet Union were often regarded as the first test of the new world order, which is associated with the ideological notion of global governance and economic liberation only in the sense of new collective efforts to identify, understand, or address worldwide problems that go beyond the capacity of individual nation-states to solve. Thus, integrated markets, especially energy markets, are included in the world economic system, as events affecting energy security in one part of the globe could threaten countries far removed from potential conflicts (Gaddis 2006).

Later, the terrorist attack on September 11, 2001, collapsed not only the prices of oil but also caused Afghanistan and the second Iraq wars. The conflicts between to the major oil-producing countries in the Middle East have been continuing since then. The US-Iran conflict and the wars in Syria and Ukraine are some of such conflicts. On the other hand, the discoveries of natural gas in such regions as the Eastern Mediterranean and the development new unconventional hydrocarbon (shale gas and shale oil) production techniques have started a revolutionary era starting 2007, especially in the US. The shift in the world economy that is increasingly powered by natural gas has significant effects on global energy geopolitics. Competition for their control and access to natural gas resources, their export routes, and market characteristics began setting the international relations agenda. With the participation of new regional players in a multi-polar world, some rule setting countries started to shape the international politics, while others remained only as rule followers. The new situation also revealed continuous formation of coalitions around specific political and economic principles and interests (International Gas Union 2012).

Since geostrategy cannot be separated from the economy, a new concept called "geo-economics" has been introduced recently (Luttwak 1990). It is defined as the combination of economic and geographic factors relating to international. The multipolar world order of complex energy interests and energy security, regional wars, the greed of big energy corporations and growing nationalism will make the future research on geo-economics even more interesting.

1.5 Energy Economics, Finance, and Geostrategy: Issues Covered in This Book

The chapters of this book are organized into three parts, namely energy economy, finance, and geostrategy. All of the articles, which have undergone a blind double peer-review process, contain contemporary and original views on several energy issues. The first two chapters of the book are intended to introduce the book to the readers and give a brief idea about the chapters in the book. Chapter 2, which is entitled "Geostrategic Considerations on Energy" emphasizes the foreign policy guided local, regional, or global factors of energy. The author of this chapter, Rafet Akgünay, addressed the geostrategic ramifications of essential events and threats that are closely linked to major oil and gas resources.

1.6 Energy Economy

There are two chapters on energy economics issues in one developed and one developing country in this part of the book. The Chap. 3, which is written by Reinier Verhoog and Matthies Finger entitled "System Dynamics Simulation to Explore the Impact of Low European Electricity Prices on Swiss Generation Capacity Investments." The authors analyze the implications of low energy prices of European electricity markets in the last decade on the Swiss electricity market, which is facing the additional challenge of phasing out nuclear power plants and market liberalization. The authors utilize the system dynamics to a model and simulate the long-term impacts on investments in new generation capacity, security of supply and future electricity prices. The application of Monte Carlo Simulation Model indicates that the current low electricity prices are likely to persist for another decade. A possible response to the low prices is an underinvestment in generation capacity, with the risk of an energy crisis and price spikes as it coincides with the decommissioning of nuclear power plants. Finally, they observe a shift towards renewable energy sources and natural gas-fired power plants, resulting in more volatile electricity prices. These findings are similar to earlier studies of the liberalized German and Belgian electricity markets, which are also facing the challenges of a nuclear phase-out under depressed European prices.

The second chapter (Chap. 4) of this part focuses on Turkey which has a newly developed energy market. In this chapter entitled "An Investigation of the Turkish Natural Gas Distribution Market," Okan Yardımcı and Mehmet Baha Karan investigate the effectiveness of regulation in the Turkish natural gas distribution sector by examining various implementations of the board and the efficiency, productivity and service quality analysis of the distribution companies. They concluded that some of the regulations did not produce sufficient results in the Turkish gas market by comparing the private and state-owned companies according to their performances and R&D expenditures. Finally, the authors underline that the regulations to encourage sector development and cost reduction through R&D have not been properly implemented, i.e., a partially regulation failure in the Turkish energy market.

1.7 Finance

The finance section consists of four chapters. The first chapter (Chap. 5), which is written by Özgür Arslan-Ayaydin, James Thewissen and Wouther Torsin explore the economic consequences of rapidly growing green economy investments in recent years. More specifically, the effect of the corporate research in green energy on the corporate performance is investigated in this chapter entitled “The Crowding-Out Effect of Green Energy Innovation.” Using the data related 130,000 patents granted by 212 U.S. firms between 1975 and 2006, they tested and compared the impact of green and non-green energy innovation on firms’ financial performance and value. The results show that while innovation increases firm performance and value, the innovation in green energy has a significant and negative impact on future operating performance and reduces firm value. They have also concluded that the investments in green energy crowd out more profitable non-green projects, thereby reducing their value and performance.

The Chap. 6 entitled “Analysing the Relationship Among Oil Prices and Basic Petrochemical Feedstock” is written by Elkhan Hasonov and Mubariz Hasonov. They analyzed the relationship between crude oil prices and prices of primary petrochemical feedstock. The authors underline that the study fills a significant gap in the empirical literature and claims that the results of this study have some policy implications. In particular, they find that prices of essential petrochemicals do not move one for one with oil prices. This finding implies that oil price fluctuations are not fully transmitted to prices of industrial products, and hence oil price changes will have only limited effects on the economy. Furthermore, their result also implies that oil companies and oil-exporting countries may use petrochemical goods as hedging instruments against oil price falls.

The authors of Chap. 7, Mehmet Baha Karan, Aydın Ulucan and Arif Özden, use operating research methodology for the financial analysis on the pipeline investments in the Southern Europe, more particularly East Mediterranean area. In the chapter entitled “Ranking of Natural Gas Transmission Projects at the South-eastern Corridor: A Multi-Criteria Approach on the Countries of the Region” Turkey’s available and potential gas transmission and LNG projects are ranked by using a multi-criteria decision-making technique called ELECTRE. The study reveals that the Israel-Turkey Offshore project is the most suitable one among other alternatives. In the second stage of the analysis, the same methodology is re-employed on Israel and found a similar result. Even considering other scenarios, the study has shown that the Israel-Turkey Offshore Pipeline Project is a priority for both countries as the interests of the two countries overlap.

The last chapter (Chap. 8) of the finance section is written by Nermin Yaşar and Erdinç Telatar. This chapter entitled “The Relationship Between Foreign Direct Investment and CO_2 Emissions Across a Panel of Countries” analyzes the relationship between foreign direct investment inflows and pollution emissions for 139 countries from 1970 to 2015. The countries are classified into four groups based on the World Bank income ranking. The primary motivation of this study is to analyze, whether the causal relationship differs between different income groups of countries. For this purpose, panel ARDL boundary approach and Granger causality test were used. The results of the study indicate that the causal relationship between FDI and CO_2 emissions differs depending on which income group the country belongs to. The authors conclude that, while there is no statistically significant short-run causality relationship running from FDI to CO_2 emission for high income, upper middle income, and low-income group countries, the pollution haven hypothesis is supported for lower middle-income group countries.

1.8 Geostrategy

The third part of the book is devoted to the geostrategy of energy and consists of five chapters. The high number of chapters in this part indicates the importance given to the concept of geostrategy in the book. Most of the chapters of this part discuss the geostrategy of oil and gas sectors that have been keeping the top place in all energy arguments during the last century. Chapter 9 entitled "Geostrategic Challenges in the Oil and Gas Sectors" identifies the significant geostrategic challenges that have emerged during the last two decades and assesses their implications for the global oil and gas sectors. The authors of the chapter, Volkan Ş. Ediger and İstemi Berk, identify mainly two significant challenges facing the oil and gas industry: energy substitution and resource scarcity. They estimate that the substitution of coal and renewables threatens to reduce oil and gas demand and resource scarcity will promote the development of unconventional hydrocarbon resources such as shale oil and gas and heavy oil. Moreover, the national oil companies (NOCs) are expected to continue dominating the industry and due to the increasing intervention of the corresponding governments, the next decades could experience a rise in state capitalism not only in significant oil and gas producing countries but also in the global energy business.

The authors of Chap. 10 investigate the geostrategy from the point of view of the European Union (EU). The chapter entitled "Geostrategy of the European Union in Energy", which is prepared by André Dorsman, Andries Nentjes, and Petr Polak claim that climate change forces the EU to reduce the use of fossil fuel, but the use of fossil fuel is vital for the security of supply. Underlying this dilemma for the EU policy, they advise that Europe must constantly speak with one voice to denounce onerous long-term contracts for gas imports from Russia and to gain a stronger bargaining position. As part of its diversification strategy, Europe must also invest in an Iran-Europe Pipeline to bring gas to Europe from Central Asia and Iran.

Chapter 11 is entitled "Geostrategic Importance of Energy Transit and a New Transit Regime under the International Energy Charter". Volkan Özdemir, the author of the chapter, focuses on the geostrategic importance of energy transit and the possibility of a new regime under the International Energy Charter. He argues that although EU market has developed their energy regulations and solved energy transportation issues, there is still lack of an energy transit regulation in broader Eurasia. He concludes an international form of transit regime for all countries and reveals that the new regional energy transit community will not only regulate the energy trade and transit among the parties to the declaration but also potentially contribute to the political stability in Eurasia as a multilateral binding legal regime that is the basis of any geostrategic calculations.

The exploration activities of offshore gas potential in the Levant Region, ongoing and planned field development and production activities, the possibilities of amount and export destinations, the options for export infrastructures, and the effect of recent discoveries in Egypt on the Levant region are discussed in Chap. 12, which is entitled "Geostrategic Importance of East Mediterranean Gas Discoveries." Sohbet Karpuz, the author of the chapter, gives an overview of the potential impact of all issues on the conflict-laden geopolitical landscape of the region regarding adding a new dimension to the power balance and forewarns the market players. He emphasizes that unless developed for the benefit of all, those resources may fuel confrontations, add frictions and anxieties to an already volatile region, and will shrink the room optimism for finding another common ground.

Vera Bekker and Bartjan Pennink are the authors of the last chapter (Chap. 13) of the book. The chapter is on "The Natural Resource Curse: A Country Case Study: Tanzania." The authors aim to uncover factors that can help developing countries with significant amounts of natural resources in avoiding the so-called "natural resource curse." Posing local economic development and innovation as sources of national economic growth (the antithesis of the natural resource curse), the paper involves semi-structured interviews with various local stakeholders on the topic of recent natural gas findings in Tanzania. They reveal that the government, knowledge and education, local participation, revenues, transparency, legal issues, and finance and capital can be seen as crucial for a successful exploitation and for creating opportunities for the local actor by applying a multi-criterion analysis.

1.9 Conclusions

This book combines the research articles on energy, economics, finance, and geostrategy to provide readers with information on the complex structure of international energy markets through some selected topics. The chapters in the book show not only the multi-dimensional structure of present day's energy markets but also the close relation of energy, economics, finance, and geostrategy in energy markets. All chapters analyze the most popular energy topics of the current world, which are discussed by market players and academicians. Priority of energy security in decision-making processes in energy markets is emphasized in almost all chapters.

This book investigates policies and market structures not only of traditional energy sources such as petroleum and natural gas but also of renewables. Although the Middle East and Eurasia regions are the focus of the book, Tanzania is presented as a case study from Africa. We hope that this book will give readers a variety of inspiration and contribute to the conduct of new research.

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Geostrategic Considerations on Energy

2

Rafet Akgünay

Abstract

After the Cold War was over during the last decade of the twentieth century, there was a brief period during which there were hopes for a better future in the world. Various organizations and several countries replaced the term of "threat assessment" with "risk analysis." Alas, it was not very long before this concept became outmoded in a relatively brief period. Risks, such as terrorism, proliferation of mass destruction weapons and their delivery means, extremism, trans-national illegal arms, narcotic and people trafficking, uncontrollable refugee crisis have led to a dangerous uncertainty in international relations. On top of all these, growing number and magnitude of unstable areas especially in the Middle East has become a major concern for the global community. This concern is exacerbated by the mere fact that almost all these alarming events take place in and around the areas of hydrocarbon-based energy sources as well as their transportation routes.

Developments such as the emergence of new overpopulated urban centers in Asia and of the concerns about climate change are also the agenda items that are closely related to the energy issues and these issues are closely followed by the world public opinion.

It is the intention of this paper, to address the geostrategic ramifications of these unfolding events and threats that are closely linked to major hydrocarbon based energy sources. After all energy and energy security have always been an important issue in world politics since the industrial revolution.

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Energy and geostrategy · Geopolitics of energy · Energy security · Oil and gas pipelines · Maritime routes

2.1 Introduction

Energy is defined as the ability or capacity to do work, and command of energy is setting the outer limits of what can be accomplished by communities, nations, or any social entity (Weissenbacher 2012). It has always been crucial for the human development all throughout the history. In the traditional world major energy sources were based on animal power, fertilizer, wood, charcoal, water and wind. These sources were rather abundant and taken for granted. However, even in the traditional era, energy was the main ingredient of economy and they had always been closely related with technology. This relation became more apparent after the industrial revolution, which necessitated energy resources with higher calorific value, such as coal and oil.

Oil and coalfields are concentrated in some regions and countries. As a result, geopolitics of energy has become a major issue both for producing and consuming countries since unlike the traditional energy sources, coal and oil are exhaustible in nature. Being the main ingredients of the modern technology they are of utmost importance for global prosperity and naturally for security (Rodrigue et al. 2017). According to the recent figures, oil provides 34% coal provides 24% and natural gas 21% of world's primary energy needs. Nuclear, hydro and other sources provide the remaining 21%. (Hopkins 2014). Wars were fought, domestic and international instabilities occurred due to the difference between the demand and supply of fossil fuels. Thus energy has acquired a political aspect in international relations making the energy and energy security more visible and moving them to the center of international relations. In this regard, this paper offers a very brief theoretical perspective and definitions on the related concepts such as security, geopolitics, threat and risk, followed by discussion on hydrocarbon related issues.

All countries whether industrialized or not need reliable energy supply in order to have sustainable development. According to the U.S. Energy Information Agency (EIA) net imports (imports minus exports) of petroleum of the U.S. from foreign countries in 2016 were equal to about 25% of U.S. petroleum consumption. Likewise, most of the other industrialized countries in Europe as well as the newly emerging industrial powerhouses like China and India depend on foreign hydrocarbon resources. Given the fact that dependence on these resources is not limited to only industrialized world one can easily conclude that the energy security and politics is not confined to a certain region or certain countries—whether they are exporting or importing. What is more, despite the disagreement between the economists many geologists firmly believe that oil production has reached at its peak and will soon sharply decline (Cudahy and Richard 2008). These uncertainities about the future of oil production, has led to a global tendency to treat energy insufficiency as a national security problem. After the oil crisis of the 1970s and especially in the new security environment of post 9/11, energy politics and energy security—with its various aspects—has become even more crucial in international politics.

As an outcome, certain principles have started shaping the energy security policies especially of the energy thirsty countries including several European countries. Among these principles diversification is one of the most, if not the most prominent one. This principle covers the diversification of the sources, supply routes and the infrastructure.

Eastern Mediterranean, located at the crossroads of Europe, Asia and Africa, lies in the heart of major oil and gas fields. It is also a historical maritime route, which nearly a third of world trade passes through, including 30% of the world's oil and two-thirds of the European energy supplies (Schivardi 2016). However, this area is a volatile part of the world with several conflicts including frozen ones, threatening the energy security as well.

With this perspective, it can be argued that the Mediterranean Sea, especially the Eastern Mediterranean is an area, which needs special attention as it is done in this paper. Due to its dynamic and multi-disciplinary nature, the topic holds implications for the literature in terms of geopolitics and security. Moreover, the changes in the energy paradigm create new risks and opportunities for the global actors as well. Therefore, the topic also offers policy makers, industry actors and the public agents a new perspective in tackling the issues.

With this perspective, this article adapts the concepts of energy geopolitics and security in response to the evolving issues of energy resources. More specifically, the article aims to bring forward the development in the energy resources, the rising energy oriented risks and threats on energy security and geostrategy, and the geopolitics of hydrocarbon energy resources especially within the Eastern Mediterranean region. In consideration that energy geopolitics, energy security and geostrategy are all a part of a dynamic process, which has ongoing impacts on regional politics, the article intends to offer a stronger perspective in approaching these questions.

In this respect, the article is organized as follows. Section 2.2 offers various related contemporary definitions by firstly, reviewing the literature on security and energy security, and secondly, positioning the article in terms of the literature on geopolitics. Section 2.3 offers a conceptual and historical discussion on the risk and threats associated with hydrocarbon resources, setting the scene for the main argument that, together with the security problems related to hydrocarbons and the rapidly growing need for oil and gas, the dependency on these resources is significantly growing. Section 2.4 briefly discusses the hydrocarbon issue and the Eastern Mediterranean in an historical perspective. Finally, main argument is summarized in Sect. 2.5.

2.2 Contemporary Definitions of Energy Security

The concept of security is on the permanent agenda of the policy makers and the scholars of modern international relations. However, there is no consensus on the exact definition of this concept. In traditional terms, security has been closely related with the use of military power. This notion, though, has been changed by the emergence of new dimensions in the strategic environment. Today, any reference to the concept of "security" generally follows rather a holistic approach and includes other factors, such as environmental, economic and welfare issues. Thus, security can be defined as defensive (in relations to a threat) or offensive (optimizing of profits in relations with other actors) point of view.

Whereas energy security can be defined as a condition in which a nation and all (or most) of its citizens and industries have access to adequate energy resources at reasonable prices for the foreseeable future, free from serious risks of major disruption of service (Hancher and Janssen 2004). This definition is in line with the International Energy Agency (IEA)'s approach which highlights two important components: "the *uninterrupted* availability of energy sources" and at an "*affordable* price". To be more precise, from the perspective of energy security, there might be different kinds of interruption of energy resources such as weather conditions, technical difficulties, malfunctioning of the facilities with long or short-term consequences. The IEA asserts that the long-term energy security mainly deals with timely investments to supply energy in line with economic developments and sustainable environmental needs. Short-term energy security, on the other hand, focuses on the ability of the energy system to react promptly to sudden changes within the supply-demand balance (International Energy Agency). In an inclusive manner, Hernandez defines energy security "as the sufficient and continuous supply of the energy necessary for carrying on the life and activities of the nations, both individual and collective." (Hernandez 2014, p. 46)

As these approaches indicate, energy security is closely related to high dependence on energy imports for the energy importing countries. When addressing the availability and accessibility of energy, several other factors, such as research, development, political instability in producing countries, as well as during the transportation, distribution or marketing phases should be taken into consideration. Physical protection of the facilities in the consumption networks has also been taken into consideration (Gençtürk 2012).

Lack of energy security is thus linked to the negative economic and social impacts of either access to adequate physical availability of energy, at reasonable and competitive prices for the foreseeable future, free from serious risks of major disruption of service (Hancher and Janssen 2004).

In short, the term energy security is a multi-dimensional and interdisciplinary notion covering a wide spectrum requiring strategic concepts and holistic means especially in dealing with fragile states, arising from various causes, such as, natural disasters, terrorism, poor regularity designs, lack of investments, or *geopolitical instability* (Redgwell 2004).

Cohen approaches the concept of geopolitics as the analysis of the interaction between, on the one hand, geographical settings and perspectives and, on the other, political processes. According to him, the settings are composed of geographical features and patterns and the multilayered regions that they form. As a result of this approach, "the political processes include forces that operate at the international level and those on the domestic scene that influence international behavior. Both geographical settings and political processes are dynamic, each influences and is influenced by the other" (Cohen 2003).

Geopolitical interests should, therefore, be strategically managed and this strategic management leads us to geostrategy (Brzezinski 1998). Hernandez (2014) reminds that whereas the concept of geostrategy was traditionally exclusively related to the military field, it has now evolved into a more comprehensive concept. As a result, it has nowadays a much broader dimension and it intends to study large topics such as military, economic, and political on a global scale, and not just in relation to geography. In other words, its contemporary definition covers more aspects than just its physical one. Consequently, when the geostrategic dimension of energy is referred at, it is directly related to geopolitics. These two concepts mutually influence each other. Geopolitical instability, thus, is a derivative of several concerns combined, including the global threat of terrorism targeting oil and gas industry. In this sense, physical security of the energy resources is an important element that carries priority for all the countries.

In the world today, hydrocarbons have the highest proportion both in energy production and consumption. However, these resources are rapidly being exhausted. Political and academic circles are currently discussing and searching other options available to meet the future energy demand. Since the renewable energy, especially sun and wind power, are basically obtained from resources available domestically, technological developments may provide new opportunities for fossil fuel importing countries. As far as the geopolitical environment is concerned, opportunities presented by technological developments in the production of the renewable energy area are opt to be limited. In case of a major shift from fossil fuels to renewable energy resources, the players will change and the technologically more advanced countries will start dominating the market. Competition among them and dependency of the technologically less developed countries to the foreign source may create new problems. What is more, renewable energy production will continue to use the similar, if not the same energy networks infrastructure.

Therefore, it can easily be said that although, renewable energy resources will definitely help in building a healthier and a greener environment, at the geostrategic level, it is not a panacea for the problem. Foremost, however, it should be noted that energy security is primarily an essential component for fossil fuels since the renewable energy is basically obtained from resources available domestically. As an outcome of this fact, geopolitical dimension of energy security has to be taken into consideration. Hydrocarbons constitute the major input of modern technology. Alas, neither the production fields of hydrocarbons nor the consumption centers are distributed evenly. As a result of their uneven distribution in the world, they have to be transported over long distances primarily through pipelines or by tankers.

Pipelines crossing various countries or tankers traveling in high seas for long distances require close cooperation among the countries in order to secure worldwide trade in energy goods, to avoid short-term supply interruptions and to encourage quality of services as well as technological innovations.

As a matter of fact, the main crude oil reserves are largely found in the Middle East especially in and around the Gulf area. USA, Canada, Russian Federation and other former USSR countries, China, Northern Africa, African countries neighboring Gulf of Guinea, Brazil and Venezuela are the other main producing countries. According to the United States Central Intelligence Agency 2015 figures among the "Total Petroleum And Other Liquids Production" of the top 20 producer countries seven are Middle East and North African countries, namely Saudi Arabia, Iraq, Iran, United Arab Emirates, Kuwait, Qatar, Algeria, Oman. These countries are also among the top 20 producers. Apparently this listing has not changed in 2016 (CEO World Magazine). Azerbaijan should also be added to this list since, the official Azeri figures show that this country is heavily dependent on its exports through Mediterranean. State Oil Company of Azerbaijan announced that "14,707,802 tons of oil were exported from Ceyhan in January–July" of 2017 through BTC Pipeline (State Oil Company of Azerbaijan Republic).

According to the Institute for the Analysis of Global Security, while OPEC countries produce about 40% of the world's oil, they hold 80% of proven global reserves, and 85% of these reserves are in the Middle East. Actually, it is a sad fact of life that many of the world's leading oil producing countries are politically unstable and most of them are members of the Organization of the Petroleum Exporting Countries (OPEC).

Energy security is not a new concept. It has particularly been a major preoccupation for many countries especially since the oil crisis of the 1970s. The geopolitical tensions of 1973 and 1979 in the Middle East had been an eye opener for several circles to show how delicate and important that the energy security was. In both cases, what was at stake was the supply security. Developments following the Arab-Israeli War of 1973 and the Iranian revolution of 1979 showed that international or domestic disturbances might have a negative effect on not only the security of production but also prices, leading to turmoil in global economy. During those years, corresponding to the Cold War era, the main focus of concern was rather military in nature. Interruption of the flow of energy was primarily confined to the wars involving oil fields, geopolitical tactics and unlikely possibility of threats on tankers by submarines. In other words, energy security including transit security had been seen from the perspective of East-West security strategic equation.

With this perspective, in consideration of the developments in the energy resources and their relation with geopolitics and security, this article approaches the issue in line with Brzezinski (1998) and Hernandez (2014). Clearly, the developments create opportunities as well as risks and threats. Therefore in discussing such a matter, the necessity of acting strategically and the multi-dimension (military, economic, political) impacts of the developments must lie at the center of the discussion.

2.3 The Developments, Risks and Threats on Energy Security and Geostrategy During the Post-Cold War Era

2.3.1 Conceptual Discussion

The end of the Cold War raised new hopes and expectations in the world in general. The term "threat" was replaced by the term "risk". In this respect, the best example would be to review the "Alliance's New Strategic Concept of 1991" adopted by the Heads of State and Governments of the NATO Countries (The Alliance's New Strategic Concept of 1991). In this document, NATO officially set aside the term "threat" replacing it with a much-diluted concept of "risk".

According to Williams (2016), although the understanding and explanation of it has changed over the years, risk is a term that has been used for centuries. Today, when used colloquially, it may refer to danger or peril or even used as a synonym for threat. However, he argues where as "risk is an equation or estimation of the odds that danger will be realized or that a given course of action may have an adverse effect", threat relies on three different components. These components may be presented as an "actor" posing an actual or perceived threat; "capability" to follow through on the threat and finally to have "power" to employ this capability. "Threat thus requires an actor who expresses intention and has the ability to do harm" in other words the ability to inflict intentional damage (power). Clearly, both risk and threat are dependent on perception and for the purpose of this article it should be well specified.

Accordingly, the international organizations such as the North Atlantic Treaty Organization (NATO), European Union (EU) and the United Nation (UN) approach risk as "…the expected losses (lives lost, persons injured, damage to property and disruption of economic activity) due to a particular phenomenon—a function of the probability of particular occurrences and the losses each would cause…" and threat as "…(1) The sum of the potential strength, capabilities, and intentions of any enemy which can limit or negate mission accomplishment or reduce force, system or equipment effectiveness. (2) A menacing indication of danger to a nation's military forces, industrial base, territory, possessions or population. Such a threat generally arises from an adversary nation's military power as manifested by technological capability, military budget, military industrial production capacity, military alliances and the maintenance of conventional and strategic forces at levels beyond that required for legitimate defense. (3) A menacing indication of imminent danger to friendly forces. Such a threat generally arises from the employment of an adversary's offensive or defensive forces in an area of military operations (NATO-EU-UN Glossary).

Perhaps in a rather simpler way, differences are made between the risks that could materialize against our interests, and, threats directed to these interests, with an evident intention to damage them (Zaragoza 2016). In the "Alliance's New Strategic Concept of 1991" of the North Atlantic Treaty Organization (NATO) risk is defined as the "build-up of military power and the proliferation of weapons technologies in the Southern Mediterranean and Middle East, including weapons of mass destruction and ballistic missiles capable of reaching the territory of some member states of the Alliance. Among other risks of a wider nature, disruption of the flow of vital resources and actions of terrorism and sabotage" were also mentioned.

After the Cold War was over during the last decade of the twentieth century, the western world started to discuss concepts like "peace dividend" and the "end of history". Replacing risks with threats and focusing on new concepts reflected the emerging optimism in the world which did not last long and the west and the rest started coping with the new realities not long after the collapse of the Soviet Union. The NATO Strategic Concept which was adopted in 1999, mentions that some countries in or around the Euro-Atlantic area face serious economic, social and political difficulties, ethnic and religious rivalries, territorial disputes, inadequate or failed efforts at reform, the abuse of human rights and the dissolution of the states.

2.3.2 Historical Discussion: The Energy Security of Hydrocarbon Resources

These issues mentioned in the NATO's Strategic Concept are valid for the energy security as well. In previous decades growing import dependency on hydrocarbons was the primary concern in the energy security studies. Besides shortages due to the scarcity of fossil fuels were discussed yet another topic but not at the same level as the import dependency. Both of these subjects are related to supply security. Risks that were brought to the agenda in the 1990s, such as the proliferation of mass destruction weapons and their delivery means, extremism, international or transnational terrorism, piracy and political instability, climate change, energy infrastructure, failing states, mass migration and refugee crisis are among the main considerations related, among others, to energy security and have gradually become part of the daily routine, right after the Cold War ended and especially after 9/11 terrorist attacks in the United States.

This issue has continued to be tackled in the new versions of the NATO's Strategic Concepts. The current concept dated 2010 asserts, "All countries are increasingly reliant on the vital communication, transport and transit routes on which international trade, energy security and prosperity depend. They require greater international efforts to ensure their resilience against attack or disruption." (The Alliance's New Strategic Concept of 2010.)

This document also claims that many countries including most of the NATO allies will become more dependent on foreign energy suppliers and in some cases, on foreign energy supply and distribution networks for their energy needs. As a larger share of world consumption is transported across the globe, energy supplies are increasingly exposed to disruption.

International Energy Agency forecasts, that in 2016, worldwide average demand of oil and liquid fuels increased to nearly 96 million barrels per day and it foresees demand crossing the 100 million barrels per day threshold towards the end of its 5-year outlook period. The same international body expects that by the year 2015, non-OECD Asia will remain the major source of oil demand growth, with volumes increasing from 23.7 million barrels per day in 2015 to 28.9 million barrels per day in 2021, though the rate of growth is affected by reductions in subsidies and efforts to tackle pollution. China will be central to demand growth, partly because of the underlying rise of oil demand but also due to its build-up of strategic reserves that will reach at least 500 million barrels by 2020. This trend for China is set to continue to 2040, as oil demand from the transportation sector is growing strongly there as well as in other non-OECD countries such as India (International Energy Agency).

2.3.2.1 Terrorist Threats

Parallel to the rising importance of the of the global energy resources, the threats possessed against the natural resources have also risen in four major areas. Firstly, the piracy and terrorist threats targeting hydrocarbon resources have significantly risen. Secondly, pipelines passing through conflict zones also constitute a problem regarding the secure transmission of oil and gas from the production fields to the markets. Thirdly, with the adoption of technological sophisticated facilities cyber-attacks have also become an area of threat. Finally, other risks or threats related especially to the sea-lanes of communication also dominate the global agenda.

Firstly, the disruption of oil or gas flows as well as the piracy and terrorist threats targeting hydrocarbon sectors have risen sharply recently. According to the University of Maryland's Global Terrorism Database, as cited by Tyagi (2016), in 2013, 600 out of 2600 total terror attacks targeted oil and gas sectors, the majority of them having concentrated in the Middle East and North Africa. Based on the same data, Tyagi points out that in 2003 roughly 25% of terrorist attacks were aimed at the energy sector. Between 2003 and 2007, this figure has jumped to 30% and 35% respectively (Tyagi 2016).

The Energy Infrastructure Attack Database (EIAD) shows that, during the first decade of the twenty-first century there were, on average, nearly 400 annual attacks carried out by armed non-state actors on energy infrastructure worldwide that is almost double in comparison to years prior to 1999. This data also reveals a global picture indicating that the violent non-state actors target energy infrastructures to air grievances, communicate to governments, impact state economic interests, or capture revenue in the form of hijacking, kidnapping ransoms, theft (Giroux et al. 2013). The above figures show that almost four million tons of crude oil has to be transported from producing countries to the consuming ones every day, either by means of land or sea communication routes at a time when the energy infrastructures are faced a varying level of threat from theft to sabotage worldwide.

The security of the oil and gas sources and their facilities, safe and secure transportation of crude oil, natural gas and oil derivatives to their destinations have become an important priority national security issue for many nations. In this regard, several points and areas are now considered as choke points in the open seas. Attacks appearing in the energy maritime areas are not limited to the terrorist attacks. Piracy and thefts in some parts have reached unacceptable levels.

As already mentioned, NATO's Strategic Concept which was adopted during the post-Cold War environment in 1991 mentions about the risks posed by rogue and failed states, the proliferation of weapons of mass destruction and other transnational threats such as terrorism, ethnic or religious disputes. However the magnitude of several of these risks, especially of all kinds of terrorism was foreseen at a level of real threat. These assessments have been reformulated after 9/11 terrorist attacks.

Actually, attack on a 157,000-ton French crude oil tanker M/V Limburg in the Arabian Sea by a suicide boat in October 2002 was an eye opener. This was followed by a deadly attack, claimed by Abu Sayyaf Group, on Filipino passenger ship Super Ferry in 2004. Previously, USS Cole was the target of a terrorist attack off the coast of Yemen. Primary response to these attacks was shown at national and international level as counter terrorist operations at sea. Operation Active Endeavour, which was NATO's only article 5 operation on anti-terrorism initiated as support to the United States immediately after 9/11, to demonstrate NATO's solidarity and resolve in the fight against terrorism and to help detect and deter terrorist activity in the Mediterranean, is a good example of NATO-led engagement in the Mediterranean Sea, which was carried out from October 2001, until Operation Sea Guardian replaced it in November 2016. Operation Active Endeavour's mission was to "patrol the Mediterranean and monitor shipping to deter, defend, disrupt and protect against terrorist activity" (NATO Allied Maritime Command).

Besides terror oriented attacks, piracy and theft in several areas of the world are worth mentioning. As Hanson argues, "Although maritime piracy is a worldwide problem, there are several areas that track particularly high levels of pirate activity. These areas are the Gulf of Aden, near Somalia and the southern entrance to the Red Sea, the Gulf of Guinea, near Nigeria and the Niger River delta, the Malacca Strait between Indonesia and Malaysia, and the Indian subcontinent, particularly between India and Sri Lanka" (as cited in Sullivan 2010). According to the latest International Chamber of Commerce International Maritime Bureau (ICC IMB) piracy report, pirates and armed robbers attacked 43 ships and captured 58 seafarers in the first quarter of 2017, slightly more than the same period last year. The global report highlights persisting violence in piracy hotspots off Nigeria and around the Southern Philippines. Indonesia also reported frequent incidents. During this period, armed pirates hijacked two vessels, both off the coast of Somalia, where no merchant ship had been hijacked since May 2012. Four attempted incidents were also received. The same source cites that between 2010 and 2014 actual and attempted piracy attacks in the Southeast Asia jumped from 70 to 141 on a yearly basis. In 2016 alone, number of pirate attacks on tankers totaled 89 (ICC IMB n.d.).

Several countries or international organizations jointly acted to prevent and deter piracy in different parts of the world. One of these areas was off the Somalia Coast. Disruption of shipping in here was not only important for the main global maritime trade routes but for the ships delivering World Food Program humanitarian assistance to Somalia. A strengthened international response to piracy off Somalia came together in late 2008. NATO deployed it's first-ever counter-piracy mission, Operation Allied Provider, off the coast of Somalia in October 2008. The European Union and other countries also deployed naval ships to the region on counter-piracy missions, leading NATO to collaborate closely with partners as part of a broad coalition. NATO and EU together with some other countries deployed Counter Piracy Task Forces to the area (Knops 2012).

2.3.2.2 Conflict Zones and Other Risks

Together with the piracy-oriented risks, several of the land-based routes, that are pipelines, transit through conflict zones. Therefore, pipelines constitute yet another problem area for secure transmission of oil and gas from the production fields to the markets. The total length of the pipelines is estimated to be as 3.5 million kilometers, approximately, 64% of which carry natural gas, 19% petroleum products and 17% crude oil (Hopkins 2014). Pipelines carry about 40% of world's oil flows and most of its natural gas (Tyagi 2016). Luft and Korin (2003) point out that until recently, the major preoccupation of the pipeline industry has been on environmental, safety and maintenance issues. Occasional cases of vandalism, the human factor was hardly perceived as a threat to the world's vast web of oil and gas pipelines.

However this perception has now changed since pipelines running over thousands of miles and across some of the most volatile areas in the world have become rather attractive targets for terrorists.

By a simple explosive device terrorists can puncture a pipeline and render it non-operational. Due to their length, pipelines are very difficult to protect all over the globe. There have been numerous pipeline attacks in some other countries including Nigeria, Colombia and Pakistan. In Iraq, acts of sabotages against pipelines have become the biggest obstacle in bringing Iraqi oil back online. Even in the United States the 800-mile-long Trans-Alaska Pipeline System (TAPS) has been sabotaged, bombed twice and shot at more than 50 times. TAPS is not only within terrorists reach but also impossible to repair in the winter.

Another risk for pipelines is cyber-attacks. It was reported that in 2008, a section of the Baku-Tbilisi-Ceyhan (BTC) pipeline in Turkey was reportedly the victim of a targeted cyber-attack. The pipeline ruptured, exploded, and released 30,000 barrels of oil near Refahiye after hackers allegedly infiltrated the pipeline's security camera network, disrupted the network's security communication links, gained access to control equipment of a valve station, and increased the pressure in the pipeline (Bertrand 2015).

It is important to mention that terrorism, piracy and theft are not the only risks that the transportation of oil, gas and other oil derivatives are faced with. Geopolitics of energy should also take into consideration other risks or threats related especially to the sea-lanes of communication. On top of these risks and/or threats come the situations related to international crisis, which would hamper the free navigation. Free navigation would not be confined to political instabilities alone. As the concept of "geostrategy" suggests, geographical factors carry enormous importance in energy security. In this regard, critical points and areas of special strategic interest need special attention.

Incidents in these areas could be in different nature. Serious accidents may block a strategic passage whether they are very narrow, shallow straits or artificial canals. Turkish Straits, Suez Canal or Panama Canal are good examples for vulnerable passages. Among the other points and zones, The Strait of Hormuz, The Strait of Bab el-Mandeb, The Danish Straits, The Malacca Straits, The Strait of Gibraltar, Somalia's Coast and Gulf of Guinea are worth mentioning (Zaragoza 2016). Each one of these passages are important for the delivery of oil, gas or oil derivatives from producing countries to the consuming ones. Main risks differ from one to the other.

For example, the Turkish Straits are both narrow and difficult to navigate with strong currents and difficult geographical features. According to the official statistics of the Ministry of Transport, Maritime Affairs and Communication of Turkey (MTMAC), 6041 tankers, 989, Liquefied Petroleum (LPG) or Liquefied Natural Gas (LNG) tankers and 2559 chemical tankers used the Straits in 2016 (Deniz Ticaret Genel Müdürlüğü—Directorate General of Merchant Marine).

As it happened several times in the past, collisions, vessels going on ground, spillages, fire or sinking may severely disturb the sea traffic causing disturbances to the hydrocarbon traffic from the Black Sea ports used by several producing countries in the Caucasus, Central Asia and Russian Federation. It is obvious that each geographical choke point or zone is important for certain states. Besides changes in security equilibrium, new hydrocarbon discoveries, new routes of transportation may increase the sensitivities of certain areas in this respect (Hernandez 2014). Mediterranean Sea is vital for several consumer European nations as well as the oil and gas producers in this region and its vicinity. Being a semi-closed sea, the Mediterranean constitutes a very good example to understand the dynamic nature of the geopolitics of oil.

2.4 The Geopolitics of Hydrocarbon Resources in the Mediterranean: A Historical Perspective

As it is already mentioned, Eastern Mediterranean is the meeting point of various competing civilizations, cultures and monotheistic religions. It is situated at the crossroads of the Middle East the route to India and China and the West, as well as the north and the south, joining the Indian Ocean with the Mediterranean and the Atlantic Ocean. The Suez Canal was opened in 1869 and cut the distance between Europe and the South Asia by 7000 kilometers and was the vital and shortest way between the East and the West, between the colonies and the colonial powers during those years. The dramatic benefits that the Canal has brought to world trade during those years still continue.

As such, this region has always been one of the most important crossroads in world trade and its geostrategic location between the West and the Middle East and South Asia has turned the Eastern Mediterranean into a source of rivalry and thus of instability for thousands of years. This instability has never come to an end with the evolution of the means of transportation, communication and technological novice. Developments in the region such as the opening of the Suez Canal, the increase in the importance of oil and gas in the modern world which are abound in the Middle East, the emergence of the Arab-Israeli conflict after the establishment of Israel and the Cyprus issue has contributed to the already existing instability, great power rivalry and violence in the region.

The geopolitics of hydrocarbon-based energy in the Eastern Mediterranean first emerged after World War I. After the discovery of oil Iran in 1908 a new element was added to the strategic importance of the Middle East. European countries looking for new sources of supply, as well as the Admiralty in London recognized the global importance of this discovery was their oil-fired ships (Owen 2008). The Iraq Petroleum Company, IPC, which was established following the Armistice of Mudros (1918) between the Entente Powers and the Ottoman Empire at the end of the First World War, made yet another important oil exploration in the area in 1927 in the Former Ottoman Province of Mosul and it drilled wells in the Kirkuk's Baba Gurgur field. Following the exploitation of oil in the area, the Mosul-Haifa Oil Pipeline, also known as the Mediterranean Oil Pipeline had been built between 1932 and 1935. This pipeline, which was active for only 13 years, carried 1 million barrels of oil per day to the East Mediterranean. Its activity came to an end because of the Arab-Israel War of 1948.

Actually, due to the rising demand preliminary exploration work started in Iraq and Persia before 1908. However, 14 and "demand was rising even before 1914 preliminary exploration work was underway in Persia and Iraq, Middle Eastern reserves of oil were not yet as great a factor in international affairs as the became after 1945 (James 2001).

In the era we live in today, the geopolitics of hydrocarbons in this region is re-emerging. The discovery of hydrocarbon resources in the late 1960s in the Egyptian off shore, the concurrent discoveries of the Gaza Marine field in the Palestinian off shore by the British Gas Group in 2000, and finally of the Mari-B field in the Israeli offshore, added a new dimension to the geopolitics of hydrocarbons of the region. New ones in 2009 and 2010 followed these discoveries. The Tamar and the Leviathan fields of Israel were proved to hold large natural gas reserves. Recently, in 2015 the giant Zohr field at the Egyptian off shore has been discovered. According to the 2010 estimates by the US Geological Survey, the Levant Basin of the Eastern Mediterranean alone holds about 2.5 billion barrels of oil and 3.45 trillion cubic meters of natural gas reserves. According to the survey, the Nile Basin of Egypt is estimated to hold 6.3 trillion cubic meters and the Herodotus Basin, which is located in the far northwest, holds an estimated 3.5 trillion cubic meters of natural gas reserves (Schenk et al. 2010).

Current reserves are so important that they can significantly affect the energy safety and energy strategies of the European Union, the biggest market of energy resources in the region. Recent discoveries of hydrocarbons in this area make it a major potential energy field for Europe and beyond. These discoveries will definitely have repercussions in international relations and international law. Once the reserves are proved and production is fully started, transportation of it to the world markets would be another issue. At the end, discovery of hydrocarbon may constitute an opportunity or a curse for the overall strategic equation in this region and probably beyond.

Another aspect of these discoveries is the delimitation and proclamations of the Exclusive Economic Zones (EEZ) in the Eastern Mediterranean Sea. As a continuation and a result of old disputes, delimitation of maritime areas is about to become a major dispute in the Eastern Mediterranean, which is a semi-closed sea. The Aegean Sea is a well-known point in case. However, this is a dispute between only two countries. In the Eastern Mediterranean, however, there are nine parties that need to reach an agreement on the delimitation of their exclusive economic zones based on equitable and reasonable principals and solutions. Any solution, which does not take the just rights of the relevant littoral parties into consideration, is doomed to fail and will lead to further instabilities.

On the other hand, last couples of years have been a period of transition for Middle East and Eastern Mediterranean countries as the discovery of the East Mediterranean natural gas reserves is a challenging case for the region The discovery of natural gas tensed up the geopolitical atmosphere in the region which has been the scene of Iraqi, Syrian, Palestinian and Cyprus conflicts. At this point, this tension both poses serious threats and provides opportunities in the field of energy in the region. These opportunities, which emerge from conflicts and cooperation in the region, and which might demonstrate a stable or variable pattern, are reshaped by the key strategies of the regional actors. While the borders of exclusive economic regions are discussed, various alternatives for transferring the potential hydrocarbon products to Europe, which presents the largest market worldwide, are on the agenda.

Developments of the Arab Spring, and especially the Syrian War coupled with the weakening of regimes, further deteriorated the instability in the Red Sea and the Mediterranean area. The states in the region are now divided into different geopolitical blocs as Sunni, Shia and the rest. Events in Syria and Iraq attracted the great powers to the region. One can expect that the interaction between these parties would have significant impact on issues of maritime trade including transportation of natural gas from the region.

As it has been pointed out, terrorist acts and especially those originating from the Eastern Mediterranean and the Middle East have become almost daily routine. Possible terror attacks against energy infrastructure at sea, the disruption of port operations and attacks on ships especially on oil tankers in this region should not be ruled out. Therefore, security and safety carries prominence in all areas including the transportation of the gas. While Israel, Egypt and South Cyprus, together with Greece are looking for other means to transport their gas safely to Europe, Turks and many others believe that pipelines connected to the Ceyhan terminal would be the best option.

Not only littoral countries but also global powers have interests in this region as well. Russia is concerned that the East Mediterranean gas would decrease dependency on Russian gas and it can lose its hegemony over the market. Europe is closely following the updates because it wants to diversify gas suppliers. The US is in favor of supply diversification in European gas market and reduced Russian presence.

2.5 Conclusion

Almost all major industrialized countries need large and reliable energy supplies in order to have sustainable development Likewise, most of the other industrialized countries in Europe as well as the newly emerging industrial powerhouses like China and India depend on foreign hydrocarbon resources. In this regard safe transportation and stable economic and political environment, be at domestic, regional or multi-regional level are important. The above point together with the new security environment of post 9/11, has enabled energy politics and energy security—with its various aspects—to become a crucial matter in international politics.

Parallel to the rising importance of the of the global energy resources, the risks and threats possessed against the natural resources has also risen in four major areas. Firstly, the piracy and terrorist threats targeting hydrocarbon resources have significantly risen. Secondly, pipelines passing through conflict zones also constitute a problem regarding the secure transmission of oil and gas from the production fields to the markets. Thirdly, with the adoption of technological sophisticated facilities cyber-attacks have also become an area of threat. Finally, other risks or threats related especially to the sea-lanes of communication also dominate the global agenda.

Recent discoveries of hydrocarbons in the Eastern Mediterranean make it a major potential energy field for Europe and beyond. However, due to ongoing regional conflicts, the weakening regimes associated with the Arab Spring and the Syrian Civil War, and the competing interests of the global powers on region are diminishing the potential of energy fields.

All in all, like in other political outcomes, interests clashing at many points and economic benefits are the major drivers of energy geopolitics as well. It is clear that the geopolitics of hydrocarbons is not static but a dynamic concept. While the security problems related to hydrocarbons are real, the rapidly growing need of oil and gas will continue to increase dependency on these resources. This issue will continue to be an important issue of geopolitics in the years to come. Alternative sustainable energy sources may be the only way out of this dependency.

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Part I

Energy Economy

System Dynamics Simulation to Explore the Impact of Low European Electricity Prices on Swiss Generation Capacity Investments

3

Reinier Verhoog, Paul van Baal, and Matthias Finger

Abstract

European electricity markets are coping with low energy prices as a result of overinvestments in generation capacity, subsidies for renewables and the financial crisis of 2008. In this chapter we explore the implications of low electricity prices on the Swiss electricity market, which is facing the additional challenge of phasing out nuclear power plants and market liberalization. System Dynamics is utilized to model and simulate the long-term impacts on investments in new generation capacity, security of supply and future electricity prices. Simulation results indicate that the current low electricity prices are likely to persist for another decade. The most likely response to the low prices is an underinvestment in generation capacity, with the risk of scarcity pricing under low security of supply, as it coincides with the decommissioning of nuclear power plants. There is little evidence this will lead to boom-and-bust investment cycles. Finally, in the long-term we observe a shift towards renewable energy sources and natural gas fired power plants, resulting in more volatile electricity prices. These findings are similar to earlier studies of the liberalized German and Belgian electricity markets, which are also facing the challenges of a nuclear phase-out under depressed European prices.

Keywords

Electricity market · Electricity prices · Hydropower · Liberalization · System dynamics · Simulation · Switzerland · Investment cycles

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3.1 Introduction

Switzerland has committed to an ambitious energy transition with far reaching social, technical and economic consequences as nuclear energy will be phased-out, while maintaining low carbon emission levels. Nuclear energy accounted for around a third (19–22 TWh) of the country's annual electricity production in 2015 and 2016 (SFOE 2017) and is ideally completely replaced by 2034 by new renewable energy sources (RES), such as solar photovoltaic (PV), wind, (micro-)hydro, biomass and geothermal sources. However, new RES face considerable challenges: social acceptance (Wüstenhagen et al. 2007), small potential of certain RES such as micro-hydro (SFOE 2012), or low economic attractiveness (Prognos AG 2012). Hence, energy import and natural gas-fired power plants could play a central role in compensating the production deficit caused by phasing-out nuclear energy. However, Switzerland's priority to remain electrically relatively self-sufficient and the congestion already occurring in some cross-border transmission lines (Swissgrid 2015) is likely to limit future electricity imports. Furthermore, the development of natural gas-fired power plants is considered only as a last resort due to the strong commitment to limit emissions, which includes the obligation of electricity producers to offset all CO_2 emissions.

Belgium and Germany are facing a similar challenge of phasing-out nuclear energy under stringent CO_2 emission targets. In a system dynamics (SD) simulation study Kunsch and Friesewinkel (2014) find that aggressively phasing-out nuclear energy in Belgium can have adverse effects on the country's RES deployment, electricity price volatility, CO_2 emissions and energy dependency. Indeed, an early phase-out of nuclear energy can result in a large production deficit despite RES investments, requiring additional investments in fossil-based generation technologies. Such a scenario might also unfold for Switzerland, which in 2015 produced only 4.45% of its electricity from new renewables, namely 0.17% from wind, 0.45% from biomass, 1.76% from solar, 0.20% from biogas, and 1.87% from waste sources (SFOE 2016).

Switzerland is facing the additional challenge of fully liberalizing its electricity market, which can lead to "boom-and-bust" investment cycles as demonstrated by Ford (1999) and Kadoya et al. (2005) using SD simulation. In liberalized markets, investments are made based on price signals and incomplete information, rather than using a central planner approach. Periods of overinvestment send a lack of price signals to market players once the market is liberalized, resulting in a period of underinvestment (Finon et al. 2004). Conversely, long delays between permit applications and the construction of power plants lead to overinvestment, as too many projects are initiated based on price signals during capacity shortage. These time-lags are an important contributor to investment cycles (Kadoya et al. 2005). Unique to the case of Switzerland is the combination of two additional factors contributing to a lack or delay of price signals: (1) low European electricity spot prices, particularly in neighboring countries, and (2) a large hydro storage capacity which dampens the electricity price and delays investment signals (Hammons et al. 2002).

Ochoa (2007) explored the likely market responses to liberalization in the Swiss electricity market, highlighting the importance of security of supply under a liberalized market design. Since then, the Fukushima disaster and subsequent decision to phase-out nuclear energy in Switzerland have further implications for the security of supply. In this chapter, we use the definition for security of supply by Helm (2002, p. 176): "... the level of fairly stable prices that consumers might be willing and able to pay, and to see whether, given this demand, there are 'secure' supplies available". Such a definition is useful for analyzing potential scarcity pricing and "boom-and-bust" cycles in response to market liberalization and the phase-out of nuclear energy. Ochoa and Van Ackere (2009) found, using a SD model of Switzerland, that a nuclear phase-out can result in a significant electricity import dependency. More recently, Osorio and van Ackere (2016) confirmed this import dependency using a SD model of the Swiss transition from nuclear to RES. The nuclear phase-out will lower the security of supply, leading to higher and more volatile prices as a result of the new electricity-generation mix.

In this chapter, we present the design of a novel SD model for the Swiss electricity market which contains detailed endogenous investment pipelines, as well as bounded rational actors. This allows us to explore the question of investment cycles in a liberalized hydro-dominated market which is going through a nuclear phase-out. Furthermore, we place our study in the broader European context of low electricity prices and ongoing energy transitions (Verhoog and Finger 2016). In this chapter we address the following research question: What is the impact of low European electricity prices on Swiss generation capacity investments under market liberalization and nuclear phase-out policies?

This chapter is structured as follows. First, we provide an analysis of the uses and limitations of SD simulation to study energy transitions. Second, we describe the conceptual SD model developed to study the Swiss energy transition. Third, we discuss the simulation results and the impact of transition policies specific to the Swiss energy transition. Finally, we conclude the chapter by reflecting on the research question and theoretical and practical insights gained from the modeling and simulation exercise.

3.2 Methodology

Analyzing the Swiss energy transition is not straightforward, since energy systems are complex socio-technical systems (Hughes 1987; Verhoog et al. 2016) consisting of many sub-systems such as production, consumption, grids, investments, and spot markets. The complexity arises from the many parts which simultaneously interact in the energy system, resulting in complex feedback loops. Energy systems are characterized by emergent behavior which can only be explained by a detailed understanding of those feedback loops. Furthermore, there are many factors with a high impact on the energy system that have a high uncertainty, such as natural gas prices, electricity spot markets, technological developments, and (domestic) energy policies. Due in part to the long timeframe of energy transitions, typically multiple decades, it is very difficult to study how such transitions will unfold under different conditions. Computer simulation can be a useful method for analyzing energy transition by means of virtual experiments (Chappin 2011). Simulation approaches and available scenario (simulation) studies for Switzerland (Densing et al. 2016) are compared hereafter.

First, optimization models have been used to study the Swiss energy transition under the objective of cost minimization and environmental constraints (e.g. Pöyry 2012; Kannan and Turton 2016; Pattupara and Kannan 2016). These models have a central planner approach and assume perfect information, perfect foresight and economically rational decisions for the entire system. Such an approach is unsuitable to study liberalized markets with imperfect information and bounded rational investors. Indeed, such an approach would not allow for investment cycles to be explored. Furthermore, Trutnevyte (2016) found that optimization models greatly deviate (9–23%) from real system behavior in an ex-post analysis of the UK electricity system. This finding is over a period of 25 years, shorter than those typically considered for the Swiss energy transition.

Second, equilibrium models work under the assumption that the rational behavior of individuals in markets with perfect competition will find an equilibrium price (e.g. Andersson et al. 2011; Vöhringer 2012). However, such assumptions cannot be defended in electricity markets which have shown investment cycles following liberalization (Kadoya et al. 2005), as these markets are out-of-equilibrium when transitioning to their liberalized state (Gary and Larsen 2000). Furthermore, equilibrium searching models are not dynamic (Mitra-Kahn 2008), making them unsuitable to simulate boom-and-bust cycles.

Third, bottom-up simulation models of the Swiss electricity market generally have a high level of generation technology detail (e.g. Prognos AG 2012; Barmettler et al. 2013; Teske and Heiligtag 2013). Most of these models are well-documented, providing rich information required for model conceptualization, assumptions and data sources. These models rely on exogenous generation capacity expansion scenarios, resulting in rather static models which are used to explore a range of "what-if" scenarios. However, the investigation of boom-and-bust cycles requires endogenous investment calculations which allow for dynamic feedback with other system elements.

Fourth, SD models have a number of fundamental advantages over the previously discussed approaches. Teufel et al. (2013) identify a number of differentiating factors of SD models in their literature review, some of which are crucial for simulating investment cycles: (1) *time lags* in feedback processes to model lead-times for permitting and construction in generation capacity investment pipelines, (2) *bounded rationality* to model liberalized electricity markets in which firms have *incomplete information* on generation capacity expansion, (3) *social behavior* can be modeled directly, rather than relying on optimization of some objective function (Jäger et al. 2009). Incomplete information also implies that SD models incorporating the above differentiating factors do not use the perfect foresight assumption like most optimization models used for the Swiss electricity sector. Instead, forecasts are made endogenous to the modeled system using imperfect information, leading to sub-optimal system behavior over many scenarios using simulation. Such an approach deals with the inherent uncertainty of exploring the Swiss energy transition, as there is currently no historic data available of a liberalized Swiss electricity market (Osorio and van Ackere 2016).

A further argument to select SD is that our research question is concerned with system level behavior and interactions between various sub-systems which, at a structural level, are not expected to change during the studied period. A key assumption for SD is that the behavior of a system is fundamentally determined by its own structure (Pruyt 2013). The system structure is represented in stocks, flows, auxiliary variables, constants, parameters and the links (causal relations) between these elements. Therefore, it is necessary to clearly identify the justification of each link. Links can either be *positive* or *negative,*[1] and links between several elements of the model can compose feedback loops. A feedback loop is a path of links starting in one element of the system that, if followed, leads back to the starting element after passing through at least another system element. Two kinds of feedback loops can exist: *reinforcing loops* and *balancing loops*.[2] The modeled elements and links are translated into differential equations so as to allow for virtual experimentation to gain insights into the system's responses to policy designs and other scenario variables (Pruyt 2013).

3.3 Modeling the Swiss Energy Transition

The conceptual model presented in this section is an extension of the model elaborated in van Baal (2016). Additional information on the underlying equations, data and other Swiss models can be found in Verhoog (2018). Specific attention is paid to the structure, feedback loops, assumptions and publicly available data underlying the sub-systems. The model simulates the period from 2015 to 2050 with hourly time-steps, which is a unique feature compared to other simulation models available for Switzerland. The model clears the electricity market and dispatches all production units for each hour of the year, rather than using a reduced set of representative time-slices as done in Osorio and van Ackere (2016) or monthly time-steps as in Ochoa and Van Ackere (2009). Another key-feature of the model is that it allows for dynamic endogenous generation capacity investment decisions using bounded rational investor behavior. Finally, in contrast to earlier models (e.g. Kadoya et al. 2005; Osorio and van Ackere 2016) the model includes hourly transmission constraints, which are required to determine the impact of low

[1] A *positive* link from A to B means that an increase in A leads to an increase in B. A *negative* link from A to B means that an increase in A leads to a decrease in B.

[2] *Reinforcing loops* are positive feedback loops which further increase a positive or negative change in the system. Reinforcing loops can be utilized in policy design to destabilize the system. *Balancing loops* have a damping effect on positive or negative changes in the system and typically stabilize the system.

European electricity prices and interconnector congestion on developments in the Swiss market.

3.3.1 Swiss Electricity Spot Market

In liberalized electricity markets the price signals for capacity investments are sent by the spot market. The present model implements a clearing mechanism for the Swiss spot market, based on the physical hourly match of electricity supply and demand. This is a common approach for simulation models exploring the dynamics of liberalized electricity markets (e.g. Kadoya et al. 2005; Vogstad 2005; Osorio and van Ackere 2016). Vogstad (2005) additionally implemented a futures market. However, typical investment horizons in electricity markets go well beyond the horizon of a futures market, making them no more useful than expected spot price foresighting. Furthermore, capacity mechanisms as implemented by Kadoya et al. (2005) are not included in the model, as there are currently no capacity market designs for Switzerland.

Inputs for the spot market are most dispatchable generation, marginal costs per generation technology and the residual demand (Fig. 3.1). All power plants are aggregated per technology, resulting in the installed capacity. The actual dispatchable generation depends upon scheduled maintenance, such as the maintenance of nuclear power plants during summer, and the availability of water in the hydropower reservoirs. The marginal cost, the price at which the dispatchable generation technologies are offered on the spot market, is taken from Pöyry (2012), and increases on a yearly basis for fossil-fuel fired power plants. New renewables such as PV and

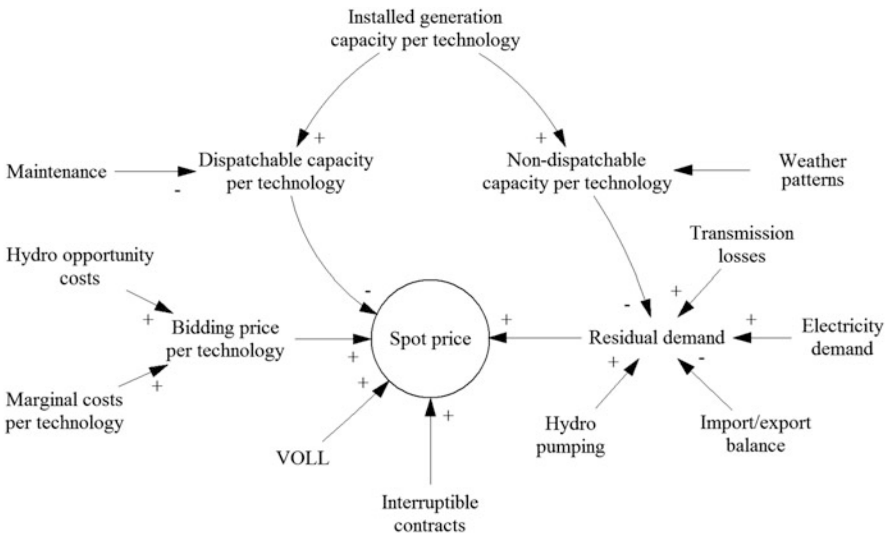

Fig. 3.1 Swiss electricity spot market

wind, typically offered at zero-cost, are depressing prices on European spot markets with high shares of renewables. Switzerland has access to long-term and low-cost import contracts with France. These contracts participate in the market clearing process at 35 CHF/MWh with around 2000 MW, are gradually reduced until 2040 (Osorio and van Ackere 2016), and are not expected to be renewed as they conflict with European market coupling rules (VSE 2012). Hydropower is an exception to the rule of marginal cost bidding, as it is offered at opportunity cost. Since hydropower plays a central role in the Swiss energy system it will be discussed in more detail in Sect. 3.3.3.

The system operator dispatches generation capacity in the most cost-efficient way to meet the (residual) demand in the system using the merit order. The least-cost dispatch is determined by intersecting the supply curve, which is made up of the price-sorted capacity bids, with the demand curve. The intersection point of both curves is the market clearing price, corresponding to the price of the marginal producer. The market clearing price will be paid for every MWh generated by dispatched generators. Complicating this process is the import and export of electricity from neighbouring countries, which happens ex-ante (i.e. before the market is cleared), changing the residual demand. In the present model, hourly spot markets are implemented for France, Germany-Austria and Italy using EPEX[3] and GME[4] data from 2010 to 2014. The hourly time series are used to create spot price profiles, which are then combined with yearly price scenario calculations based on the ENTSO-E 10 Year Network Development Plan (10YNDP) and underlying market modeling data (ENTSO-E 2014). A novel feature of the model is that hourly transmission capacity constraints are taken into consideration for all cross-border trades using net transfer capacity (NTC) values for 2013 and 2014, available from ENTSO-E.[5] Future transmission capacity expansions are based on the 10YNDP. It is important to model the NTC and potential congestion for each border since Switzerland heavily relies on electricity imports during the winter period, especially from Germany. Switzerland also has access to interruptible contracts to lower the residual demand at an estimated 900 CHF/MWh (De Vries and Heijnen 2008). Finally, when interruptible contracts are exhausted and a physical shortage of electricity supply occurs, then the clearing price will be set at the Value of Lost Load (VOLL) (Olsina et al. 2006; Hasani and Hosseini 2011), estimated at 3000 CHF/MWh (Osorio and van Ackere 2016).

Hourly electricity demand data from Swissgrid[6] is used to create standardized profiles from 2010 to 2014, which is combined with three electricity demand scenarios from Pöyry (2012), resulting in a total of 15 profile-demand scenario combinations. These scenarios are exogenous and do not take electricity price

[3]https://www.eex.com/en/market-data/power/spot-market/

[4]https://www.mercatoelettrico.org/en/mercati/MercatoElettrico/MPE.aspx

[5]https://transparency.entsoe.eu/content/static_content/Static%20content/legacy%20data/year%20selection.html

[6]https://www.swissgrid.ch/swissgrid/en/home/experts/topics/energy_data_ch.html

elasticity into consideration, as evidence of such elasticities is limited for Switzerland (Filippini 2011). The profiles are static in the sense that they are not adjusted to potential future demand profile changes as a result of electric vehicle charging, demand response, or other technological and behavioral developments. The spot market is cleared using the hourly residual demand, rather than the hourly electricity demand. First, transmission losses of roughly 7% (SFOE 2015) have to be compensated. Second, electricity demand for hydro pumping, as well as electricity exports, are added to the hourly demand. Third, electricity production from intermittent renewables such as solar, wind and run-of-river are subtracted from the demand, as they cannot be dispatched like conventional thermal or hydro storage plants. The resulting residual demand represents a shift in the merit order curve, which can push more expensive generation options such as gas fired power plants out of the market. A lower residual demand will lead to lower electricity prices and lower profits for electricity producers (Haas et al. 2013).

The available electricity generation per hour is determined by the installed capacity, maintenance and weather effects (Table 3.1). The installed capacity is driven by investment decisions, which are covered in more detail in Sect. 3.3.2. Currently, most of the electricity is supplied from reservoir, pumped storage and run-of-river hydropower plants. Run-of-river plants depend on relatively predictable water flows and cannot be dispatched since they cannot store their electricity. Reservoir hydro plants also depend on a relatively predictable natural inflow from meltwater and rain, but are modeled as dispatchable generation capacity as they can storage large amounts of hydropower. Pumped hydro plants are also dispatchable, and react more closely to market signals for pumping and production. Hydropower has a strong seasonal pattern in Switzerland, and is heavily relied upon during the higher winter electricity demand. The seasonality of hydropower water inflow is based on weekly SFOE[7] profiles from 2010 to 2014 and future inflow predictions (Pöyry 2012). Another major source of electricity production is nuclear energy, which is assumed to be phased-out according to the initial predictions, with the last plant shutting down in 2034. Furthermore, maintenance is often scheduled during the summer months, resulting in a lower dispatchable capacity. Hourly wind speed data is publicly available for non-commercial use from the NNDC Climate database.[8] Wind data from stations closest to 110 potential Swiss wind sites (Kunz et al. 2004) is weighted based on the site's size and then converted to power curves to approximate electricity production. Hourly wind data from 2010 to 2014 is used. The online European PVGIS tool (Šúri et al. 2007; Huld et al. 2012) was used to estimate yearly production figures for a 1 kW_{peak} solar photovoltaic installation in 200 Swiss cities, weighted according to population. Hourly solar irradiance data was obtained for all locations for the period of 1996 to 2000 from the EU S@tel-light

[7]http://www.bfe.admin.ch/themen/00526/00541/00542/00630/index.html?lang=en&dossier_id=00767

[8]https://www7.ncdc.noaa.gov/CDO/cdo

Table 3.1 Generation option assumptions as implemented in the model

Generation option	Capacity (MW)	Investments	Bidding price (CHF/MWh)	Dispatchable	Availability
Combined cycle gas turbines (CCGT)	75[a]	Endogenous	Exogenous[b]	Yes	100%
Combined heat and power (CHP)	0[b]	Endogenous	Exogenous[b]	Yes	100%
Solar PV	378[a]	Endogenous	0	No	Weather profile
Wind	60[a]	Endogenous	0	No	Weather profile
Interruptible contracts	–	n/a	900[c]	Yes	100%
Nuclear	3278[a]	n/a	7[b]	Yes	Seasonal
Run-of-river	–	Exogenous[b]	0	No	Seasonal profile
Reservoir hydro	9920[a]	Exogenous[b]	Opportunity cost	Yes	Dynamic
Pumped hydro	1800[a]	Exogenous[b]	Opportunity cost	Yes	Dynamic
FR import contracts	3466[d]	n/a	35[d]	Yes	100%
Geothermal	–	Exogenous[b]	20[b]	Yes	100%
Renewable CHP	56[a]	constant	42.2[b]	Yes	100%
Waste burning	342[a]	constant	7.3[b]	Yes	53%
Other thermal	542[a]	n/a	37.25[b]	Yes	100%

[a]SFOE (2014)
[b]Pöyry (2012)
[c]De Vries and Heijnen (2008)
[d]Osorio and van Ackere (2016)
For some technologies the bidding price will change over time as a result of fuel and CO_2 price developments

project database.[9] An average standardized irradiance profile was calculated and adjusted with the average yearly production for a 1 kW_{peak} installation. While the periods covered by the solar data do not overlap with the other input data of the model, this is not an issue because the currently installed capacity of PV in Switzerland is very low. We assume that the most attractive wind and solar sites are exploited first, resulting in the average utilization curve for Switzerland in Fig. 3.2.

[9]http://www.satel-light.com/indexs.htm

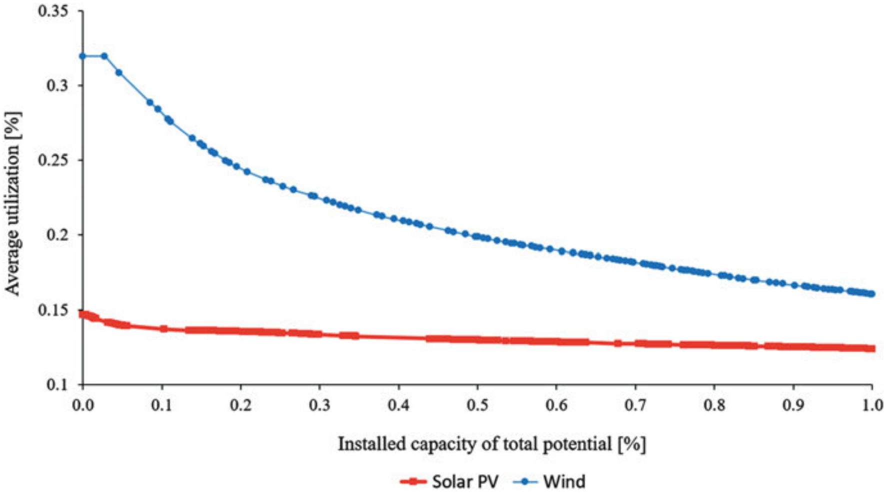

Fig. 3.2 Average yearly solar PV and wind utilization as a function of potential resource usage

3.3.2 Capacity Investments

In the current model implementation only CCGT, CHP, wind and solar investments are determined endogenously. The project pipeline in Fig. 3.3, based on the work by Vogstad (2005), is central to model bounded rational investment behavior, capacity expansion delays and resulting boom-and-bust cycles. Project permit applications are initiated when the project is expected to be profitable enough, given the investment risk associated with that technology. A proven way to model this investor behavior is by comparing the project's internal rate of return (IRR) with a corporate hurdle rate (Bunn and Larsen 1992; Olsina et al. 2006; Pereira and Saraiva 2010;

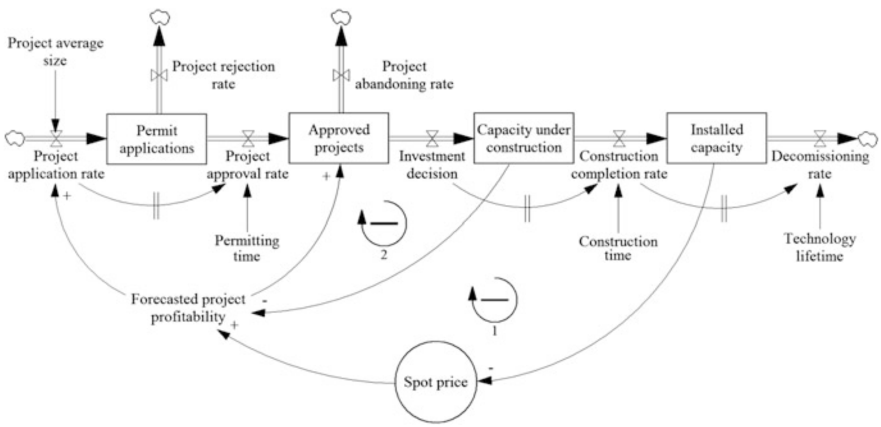

Fig. 3.3 Generic investment pipeline

Hasani and Hosseini 2011). The IRR is the discount rate r at which the Net Present Value (NPV) is equal to zero:

$$NPV = \sum_{n=0}^{N} \frac{C_n}{(1+r)^n} = 0$$

Where n denotes the time period in the project's economic lifetime N, and C_n is a cash flow at period n. The market forecast module is used to estimate the cost and revenue over the entire project's economic lifetime. The market forecast module has a similar structure to the spot market described in Sect. 3.3.1, but uses imperfect information for future generation capacity, electricity demand and spot prices. Planned capacity expansions are not known in the market if they are not yet under construction. Forecast heuristics are used to estimate the revenue over the asset's economic lifetime, taking into account the expected utilization (Fig. 3.2 for solar and wind) as well as the average price during typical production hours (e.g. daylight for solar). Capital cost, fixed cost and variable cost scenarios are taken from Pöyry (2012) to calculate the IRR. The economic lifetime of projects is assumed to be 20 years, with a hurdle rate of 9% for CCGT and CHP, 12% for solar and 11% for wind (Pöyry 2012). If the IRR is greater than this hurdle rate, then the project application is started. Subsidies for solar and wind projects play an important role in guaranteeing their profitability. However, subsidies are linked to government targets and are finite, which has resulted in large waiting lists for solar projects. Under certain conditions investments might become feasible without subsidies.

Returning to the investment pipeline; permit applications can either be approved or rejected. Low social acceptance plays an important role for wind project rejection in Switzerland, as citizens can vote against projects in their region. Another potential limitation is the number of suitable sites, which are assumed to allow for a maximum of 2282 MW installed wind capacity (Osorio and van Ackere 2016). The delay for CCGT project applications is considerable, assumed to be between 2 and 4 years in our model to explore the effect of long permit application delays. Consequently, the economics of the project might have changed by the time the permit is obtained, requiring new IRR calculations. Changes in the project's economics might result in delayed investments, or even complete project abandonment. Longer delays cause the system to respond less quickly to market signals, increasing the system's susceptibility to investment cycles (Kadoya et al. 2005). In the event that the approved project is still profitable, the investment decision is made. The capacity under construction is based on the average size of projects for that technology, meaning that capacity investments are not continuous, but rather occur in blocks of capacity representing typical power plants. Once under construction the capacity is communicated to the market, and will be taken into consideration for IRR calculations. The capacity construction introduces another delay of 1 year for solar projects and 2 years for CCGT, CHP, and wind projects. The installed capacity is available until the power plants are decommissioned after their lifetime of 25 years for CCGT and 20 years for CHP, solar and wind (Pöyry 2012).

There is an important feedback loop between the spot market and investment pipeline, indicated as (1) in Fig. 3.3. When electricity generation is short during peak demand spot prices will increase. Increased spot prices send investment signals to market players, who will respond by initiating project permit applications. After the application and construction delays the capacity becomes available, resolving the market shortage and reducing the spot price. As the spot price decreases, investment signals are no longer sent to market players. The delays play an important role, as investment signals might be broadcasted for too long (i.e. permit applications are already underway), and do not allow market players to resolve shortages quickly (Kadoya et al. 2005). There is another feedback loop (2), which gives an earlier signal to market players as soon as capacity is under construction. Expected profitability is lower as more capacity is under construction. Both feedback loops are negative, which means that they balance the system. However, given the bounded rational behavior of market players, relying on price signals and incomplete information, it is unlikely that investments are perfectly aligned with demand and supply changes.

3.3.3 Hydropower

The misalignment of investments and required generation capacity is exacerbated if market signals are interfered by the presence of large amounts of hydro production. Cross-border trading using large interconnector capacity (Sect. 3.3.4) permits Swiss dam and pumped storage operators to directly respond to seasonal and diurnal trading opportunities on foreign spot markets (Kannan and Turton 2011). Hydropower is a seasonal resource, and depends on weather and climate factors for the inflow of water. Thus, accurately modeling the capacity and utilization of hydropower is crucial for capturing seasonal patterns and effects on price signals.

Dam and pumped hydro reservoirs are modeled as stocks of water with flow variables representing natural inflow, overflow, production and in the case of pumped reservoirs, pumped inflow (Fig. 3.4). Natural inflow is based on a standardized profile using SFOE data[10] from 2010 to 2014, and are split according to installed dam and pumped hydro capacities in the model as these respond differently to market dynamics. First, dam and pumped hydro installations place bids using a different value of water, which is the opportunity cost of using stored water at a given moment (van Ackere and Ochoa 2010; Densing 2013). The value of water is directly determined by the reservoir level, as a reservoir which is not using enough stored water has a risk of overflowing. This also means that seasonal inflow patterns must be taken into consideration for hydro reservoirs. The higher the

[10]http://www.bfe.admin.ch/themen/00526/00541/00542/00630/index.html?lang=en&dossier_id=00766

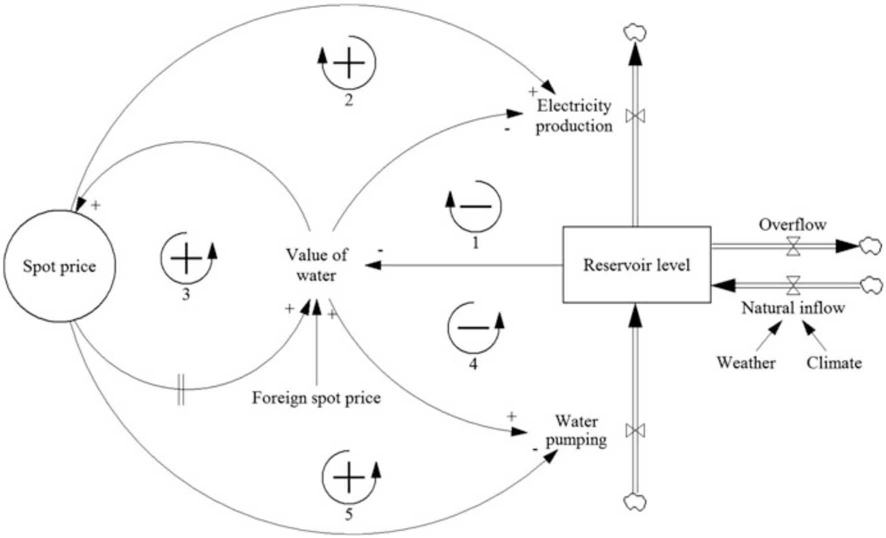

Fig. 3.4 Generic hydro reservoir. Dam and pumped hydro reservoirs are implemented separately in the model

relative filling grade of the reservoir, the lower the value of water (and bidding price), resulting in larger amounts of hydro capacity to be dispatched by the market. Feedback loops (1) and (2) ensure more hydroelectricity is produced when market prices are high, which is balanced by increasing the value of water when reservoir levels are low, resulting in less hydro capacity to be dispatched. However, there is also an implicit component to the value of water. While the value of water hovers around typical market prices its operators have a degree of flexibility to price above or below the expected marginal bid to increase or decrease the odds of being dispatched (Osorio and van Ackere 2016). As implemented, the value of water varies between 6 and 500 CHF/MWh, based on the reservoir level, domestic and foreign spot prices. Hydropower pumps are not dispatched by the market, but rather by the individual operators. Feedback loops (4) and (5) ensure that pumped reservoir levels are replenished when the value of water is high and spot prices are low, while not overflowing the reservoir. These feedback mechanisms also ensure that pumping is stopped as reservoir levels increase and the value of water drops. The most common "bang-bang" strategy found in competitive markets (Densing 2013) is implemented in the model. Under this strategy pumps only operate at full capacity when there is an economic incentive, and are fully stopped otherwise. If available, cheap foreign electricity can be used to pump hydro reservoirs as well. The endogenous operation of pumped hydro is a unique feature of our model, as pumping is assumed exogenous in other Swiss SD models (van Ackere and Ochoa 2010; Osorio and van Ackere 2016).

Finally, there is a positive feedback loop (3) which can destabilize the electricity prices in a hydro dominated market such as Switzerland. If the value of water is increased under scarcity conditions,[11] then spot prices will increase as long as hydro is the marginal producer. Consequently, the market power of hydro producers could be used strategically to increase electricity prices. However, such behavior would send investment signals and result in new capacity to be constructed, which would lower the spot price as illustrated in Fig. 3.3 feedback loop (1). In general, the availability of hydropower storage is expected to dampen electricity prices. Large storage capacities can be used to arbitrage between spot markets, within spot markets (e.g. diurnal and seasonal), and respond to supply shortages in the Swiss market. Using hydropower for these purposes, and for covering periods of shortage in particular, will delay price signals to the market until the available hydropower is inadequate to provide these services. In such an event price signals are likely to be much more pronounced.

3.3.4 International Trading

The misalignment of investments and required generation capacity is further exacerbated if market signals are interfered by structurally relying on imports from foreign markets such as France. There are a few key factors contributing to import reliance, especially during winter months (Fig. 3.5). Residual demand is higher during winter, which will increase the domestic spot price. Investment signals leading to increased investments, as part of balancing feedback loop (4), do not immediately broadcast as the market can rely on domestic hydro and imports. When foreign spot prices are lower than domestic spot prices, and sufficient NTC is available at interconnectors with that country, then electricity will be imported. The model is calibrated using historic transmission data from Swissgrid to import more electricity when the price difference is larger, as imports reduce the residual demand and domestic spot price. Switzerland is coupled to the French, Italian, and German-Austrian spot markets using ex-ante volume based bids. Commitments are made to volume exchanges before the respective spot markets are cleared, which recalling the assumption of imperfect foresight does not necessarily guarantee optimal outcomes in our model. No impact on foreign spot prices is modeled, as these markets are much larger than the Swiss market. This means that Swiss prices will converge with foreign spot prices, as shown in balancing feedback loop (1). Conversely, electricity is exported proportionally when foreign spot prices are higher than domestic spot prices, which increases the domestic demand and domestic spot prices as indicated in balancing feedback loop (2). Thus, imports and exports balance the reinforcing feedback loop (3), as discussed in Sect. 3.3.3. However, these balancing dynamics are limited by the availability of cheaper electricity and available NTC. As soon as transmission connections are congested (run out of NTC),

[11] This is not physical scarcity, but scarcity in the sense that other generation options and imports cannot satisfy demand if dam and pumped hydro are not dispatched. In such situations hydro operators could set monopolistic prices.

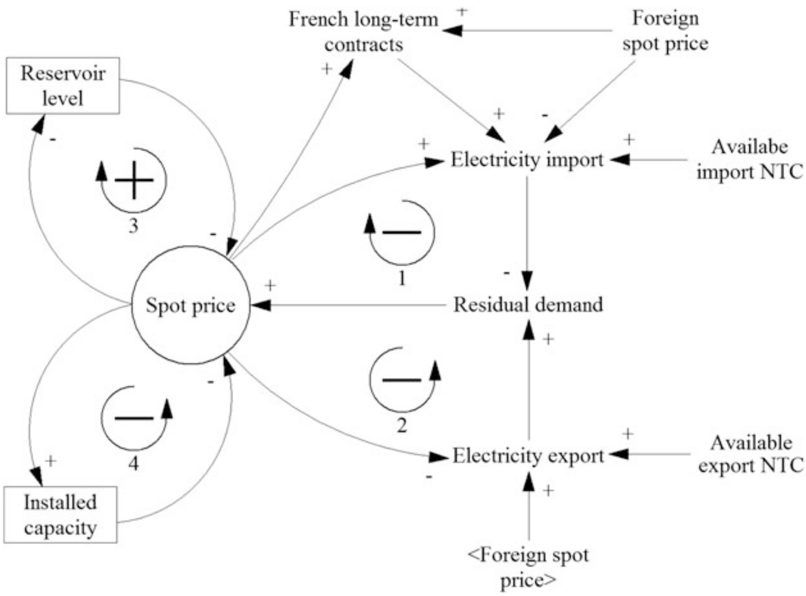

Fig. 3.5 Generic Swiss import and export dynamics. French, Italian and the coupled German-Austrian spot markets are implemented as separate exogenous spot markets in the model

then feedback loop (3) will be activated until the investment signal is strong enough. As a result, price signals in Switzerland are suppressed and delayed by the availability of large transmission capacities, low foreign spot prices and large hydro reservoirs. Due to delays in CCGT permitting and construction the market is slow to respond once price signals are broadcasted.

3.3.5 Model Verification and Validation

We tested our model along the principles laid down by Sterman (2000). He argues that all models are inherently false since they cannot pass the standard tests of falsification. Verification and validation tests of simulation models should thus aim to establish credibility and usefulness of a model. Our model passed all 12 of Sterman's standard model assessment tests. Here we will highlight two tests: boundary adequacy and behavioral reproduction.

The boundaries of the model are set at which technology is developed endogenously through investment dynamics (i.e. wind, solar, CCGT, CHP), versus those whose development is determined exogenously through scenarios. The scenario technologies are either phased-out (e.g. nuclear) or not expected to change significantly (e.g. waste burning). Hydropower is an exception, as investments are expected. However, hydro asset lifetimes far exceed the models time horizon of 35 years, and will thus not contribute to investment cycles. In addition, the model takes foreign spot market developments (e.g. Germany) as scenarios, making it impossible to identify the effect that the dynamics within Switzerland have on those markets. The focus of the model is Switzerland, which has a small market compared to its neighboring countries. The last boundaries are variables such as fuel prices, carbon prices, and technology cost developments. Since these are set on a global scale, Switzerland has virtually no impact on them.

The behavioral reproduction test, contrasting model output versus historical observations, is an important and intuitive check of the credibility and usefulness of simulation models (Suryani et al. 2010). Switzerland only recently (partially) liberalized its electricity market, hence the period with which we can compare is short. We contrasted historical data from 2010 to 2015 with our model. Models are by definition a simplification of reality, which is why the objective is not to reproduce exact historical values, but rather to replicate dynamic system behavior under imperfect information. The results of the behavioral reproduction test for the most important parameter of the model, domestic spot price, is given in Fig. 3.6. Closely linked to this parameter is the import/export balance of Switzerland in Fig. 3.7. The most important property of both parameters is their seasonal pattern, which is captured well in the modeled values. However, peaks sometimes occur earlier in the observed data. Also, the amount of export is overestimated by the model during summer and fall. Regardless, the fit of the modeled and observed values is acceptable, given the fact that we modeled a market under the assumption of a fully liberalized market, using historic demand and supply profiles. The behavioral reproduction for the hydropower module, the most dynamic, unique and central part of the Swiss electricity system, is shown in Fig. 3.8. This module also exhibits important seasonal patterns, which are captured very well by the model.

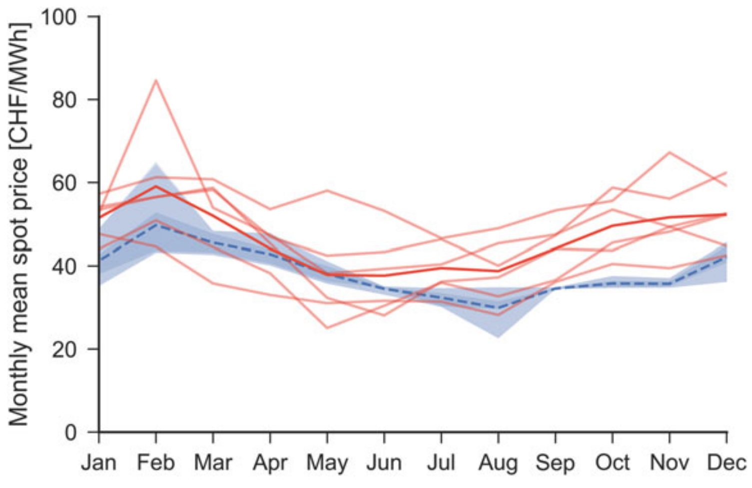

Fig. 3.6 Behavioral reproduction test for the average monthly Swiss spot price. The dashed line represents the average modeled spot price. The shaded areas respectively represent the 25–75, 5–95 and 0–100 percentile ranges. The solid lines (mean in bold) are the observed average monthly SWISSIX spot prices from 2010 to 2015, based on hourly values from the EEX platform

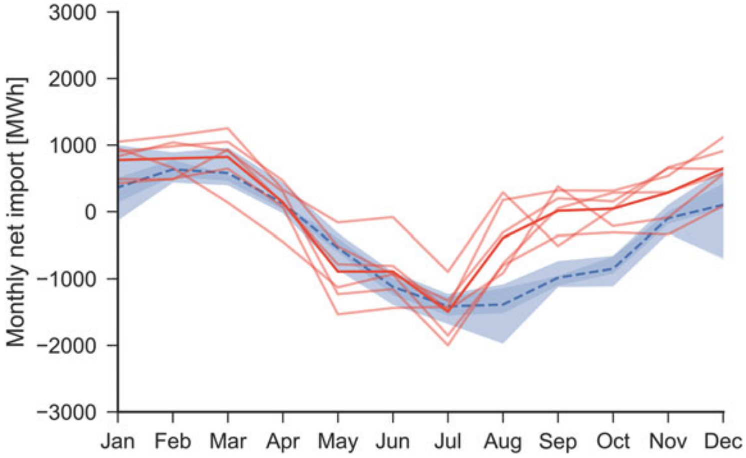

Fig. 3.7 Behavioral reproduction test for the average monthly Swiss import/export balance. The dashed line represents the average modeled monthly import/export. The shaded areas respectively represent the 25–75, 5–95 and 0–100 percentile ranges. The solid lines (mean in bold) are the observed monthly import and export values from 2010 to 2015, based on 15-min values from Swissgrid

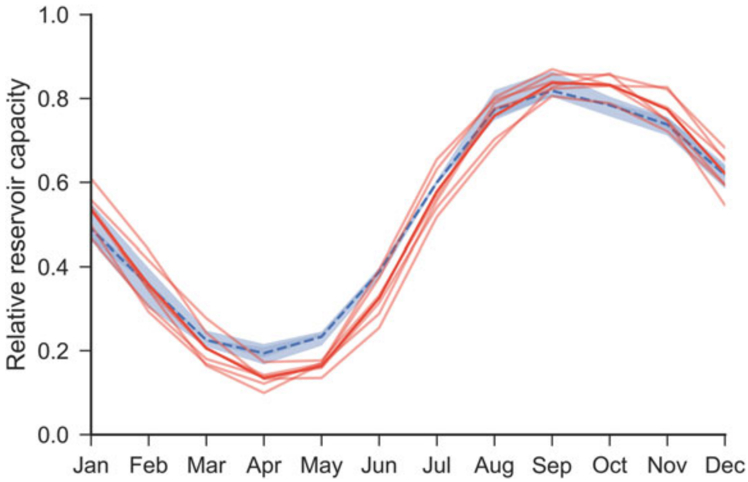

Fig. 3.8 Behavioral reproduction test for the relative reservoir capacity. The dashed line represents the modeled hydro reservoir levels. The shaded areas respectively represent the 25–75, 5–95 and 0–100 percentile ranges. The solid lines (mean in bold) are the observed reservoir filling grades from 2010 to 2015, based on weekly values from the Swiss Federal Office of Energy

3.4 Simulation Experiments

System Dynamics is a deterministic simulation approach, but long-term simulation of complex socio-technical systems is inherently uncertain. Scenarios simulation can be used to take policy and assumption uncertainty into consideration. However, the amount of simulation runs increases exponentially with the number of scenarios considered, dramatically increasing computational resource or time requirements to perform all runs. For this reason, we focus on the scenarios which are expected to be the most influential. In total 9000 simulation runs (virtual experiments) are performed over a simulation period of 35 years with hourly time-steps using Vensim® DSS for Windows Version 6.5E. Data analysis and visualization is done using Python 3.6.2, Pandas 0.20.3 and Seaborn 0.8.0. While the discussion and comparison of single runs, as is common for optimization and equilibrium models, can be illustrative, it does not do justice to the complexity and inherent uncertainty of the studied system. Therefore, we will only report the most prominent results as a subset of simulation runs for the scenarios detailed below. All graphs in this section report the modeled median value of the runs as a line, and the following percentile ranges as shaded areas: 25–75, 5–95 and 0–100.

3.4.1 Scenarios

First, an integral part of the Swiss Energy Strategy 2050 is the promotion of energy efficiency and sufficiency measures, as well as the electrification of fossil dominated sectors such as transport. Electricity demand developments have a high impact on electricity prices, especially when peak demands can be lowered. However, the package of measures and its effectiveness are uncertain. For this reason three demand scenarios are considered (Table 3.2), based on the report by Pöyry (2012): growing, stable and declining. Second, while major investments in Swiss generation capacity are endogenously determined, large uncertainty remains over foreign demand and supply developments. Due to the high level of interconnection these

Table 3.2 Scenario overview

Scenario variable	Values
Electricity demand	1 = Growing; 2 = Stable; 3 = Declining
Foreign spot prices	1 = Low; 2 = High
NTC expansion	1 = 10YNDP expansion; 2 = Constant 7500 MW
Policy options	1 = Business as usual; 2 = Delayed phase-out; 3 = Price floor; 4 = FIT cancelled early; 5 = Lower investment barriers
CCGT permitting time	2 years; 3 years; 4 years
Data profile year	2010; 2011; 2012; 2013; 2014
Solar profile year	1996; 1997; 1998; 1999; 2000
NTC profile year	2013; 2014

developments could significantly influence the Swiss market and prices. Homogeneity in foreign policy developments is assumed amongst the European member states bordering Switzerland. As a proxy for these developments two future spot price scenarios are determined based on the 10YNDP (ENTSO-E 2014): high or low prices. Third, NTC expansions are closely linked to foreign spot price developments. Lack of investments in transmission capacity might result in shortages during winter peak demand in Switzerland, while significant NTC expansions in combination with low foreign spot prices might result in electricity import dependency. Two scenarios are considered: a constant NTC value of 7500 MW (Osorio and van Ackere 2016), as well as the planned expansion figures in the 10YNDP. Fourth, several domestic policy options are considered. The business as usual option is used as a baseline, and assumes a continuation of policies as currently implemented or planned. In the delayed phase-out scenario the estimated lifetime of the nuclear power plants is increased from 50 to 60 years, extending the planned phase-out by 10 years. Potentially giving more time for investments in new renewables to compensate for the reduction in generation capacity. A price floor scenario is taken into consideration to guarantee revenues under high shares of domestic and foreign renewables. Looking at European developments in Spain and Germany it would not be unthinkable that the feed-in tariff (FIT) is cancelled earlier than currently planned. This would have significant implications for the capacity expansion of new renewables such as solar and wind. Investment barriers can delay investments despite the presence of investment signals. By lowering these barriers investors can respond more quickly to market developments. Fifth, the possibility of shortening the investment pipeline for CCGT projects is explored by varying the permitting time from 2 to 4 years. A shorter permitting time is expected to result in a quicker response by investors and less severe boom-and-bust cycles (Ford 1999, 2001; Kadoya et al. 2005). Finally, we perform simulation runs with various standardized profiles based on historic values for electricity demand, weather effects and market prices to see if the model results are robust. It should be noted that these scenarios and assumptions alone do not drive the system's behavior. Instead, the dynamics and feedback in the system's structure play an important role in determining the transition pathway. Thus, results presented in this section are likely to deviate from those given by existing scenario studies (e.g. optimization models), including the study by the VSE (2012).

3.4.2 Simulation Results

Average Swiss spot prices in Fig. 3.9 indicate three important developments. Depressed electricity prices are most likely to be sustained at less than 50 CHF/MWh, at least until 2030. The underlying cause, oversupply at the Swiss and European level, is unlikely to change due to long asset lifetimes and a possible stabilization or reduction of electricity demand. On the long-term, electricity prices are most likely to increase moderately to a range of 60–120 CHF/MWh by 2050. The behavior of the system is a gradual increase in the electricity price after phasing-out

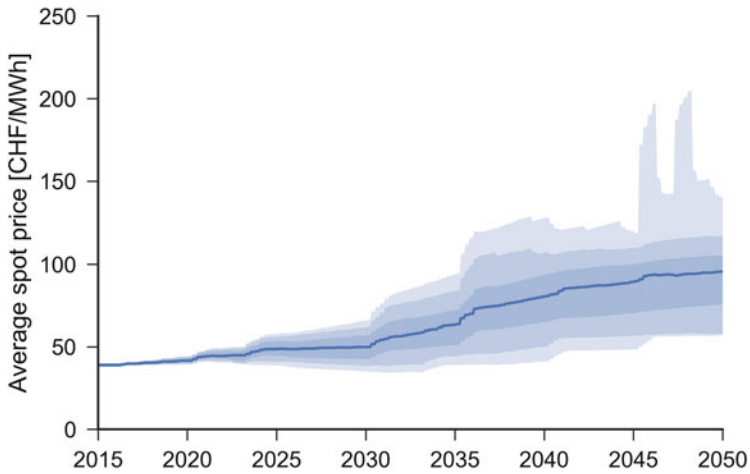

Fig. 3.9 Average spot price over 9000 runs. The solid line represents the modeled median average Swiss spot price

the final and largest nuclear power plants in Switzerland. As a result, the liberalized electricity market will not be broadcasting strong price signals for capacity investments in most scenarios. However, Fig. 3.9 is visually dominated by the occurrence of electricity shortages on the long-term, leading to high average spot prices. While these events have a low likelihood to occur, further investigation is warranted due to their disproportionate impact on consumers (De Vries 2007).

The modeled price spikes indicate a shortage of electricity supply, despite investments in RES. In fact, installed capacities should be more than enough to cover electricity demand, even during peak hours. However, not all installed capacity is available during winter peak hours, especially intermittent renewables such as PV. For this reason the de-rated capacities as presented by Osorio and van Ackere (2016) were used to plot the de-rated capacity against the peak demand in Fig. 3.10, which is a visual representation of the security margin. The security margin is the

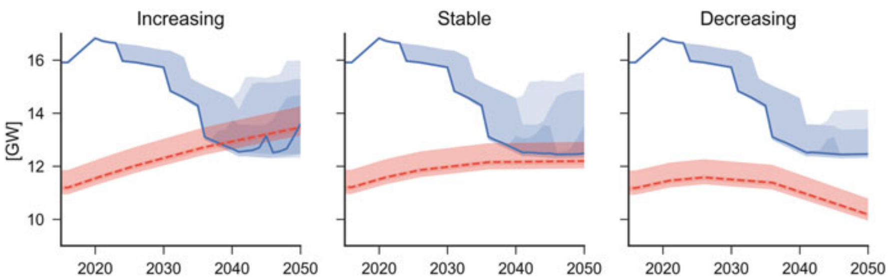

Fig. 3.10 De-rated capacity and peak demand. The solid line represents the modeled median de-rated capacity over 3000 runs per demand scenario. The dashed line represents the modeled median peak demand

relative amount of de-rated capacity versus the peak demand. Currently, peak demand is well below the de-rated capacity in Switzerland, which is reflected by the low and stable spot prices. When the de-rated capacity falls below the peak demand, then shortages, blackouts and scarcity prices can occur (Cepeda and Finon 2013). However, even periods leading up to scarcity can be marked by higher price volatility (Osorio and van Ackere 2016). This is exactly what can be observed from Figs. 3.9 and 3.10, as the de-rated capacity falls below the peak demand we observe scenarios in which scarcity pricing occurs. This mainly occurs in the scenarios where demand increases, highlighting the important role electricity demand reduction can play during the nuclear phase-out. However, scarcity pricing does not always occur in the increasing demand scenarios. Moreover, there seems to be a delayed and severe response by the spot market when the de-rated capacity falls below the peak demand. Why do we observe these delayed and lacking responses by the Swiss electricity market, which are well beyond delays inherent to the investment pipeline? To answer this question, a subset of 3000 simulation runs with increasing electricity demand is considered beyond this point.

There are indications in Figs. 3.9 and 3.10 that market signals are being distorted by hydropower and imports. About half of the scenarios are expected to experience shortages by 2040, under growing electricity demand assumptions (Fig. 3.10, left-hand graph), which are not met by scarcity pricing in most cases (Fig. 3.11, left-hand graphs). Hydropower plays an import role in maintaining stable and low electricity prices as long as there is adequate production capacity available. However, as soon

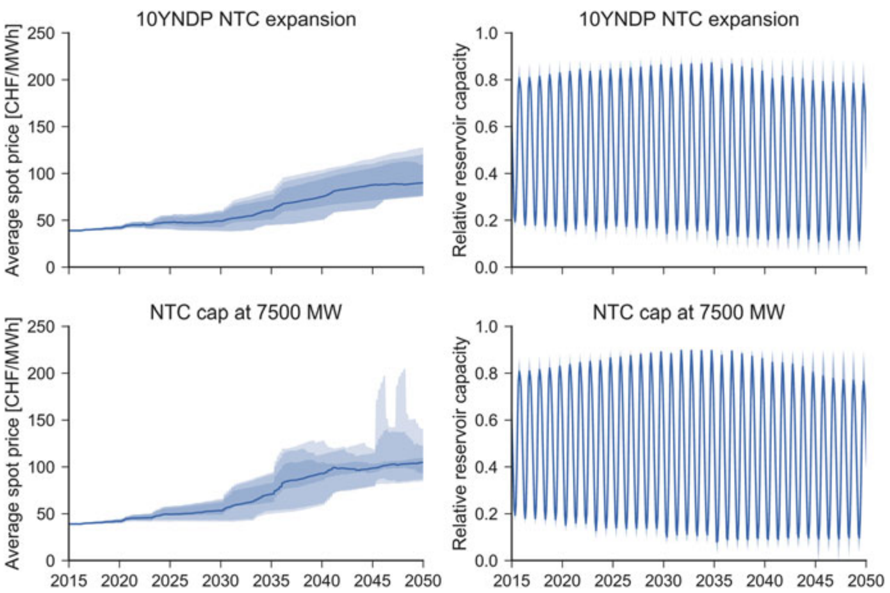

Fig. 3.11 Average yearly spot prices (left) and available hydropower reservoir capacities (right) over 3000 runs. All graphs display simulation experiments under increasing electricity demand assumptions

as the electricity market is faced with shortages, and especially when imports are constrained, then hydro reservoirs quickly prove inadequate. The maximum delay in price signals seems to be less than a year, as hydropower will signal scarcity prices when reservoir levels are too low. More importantly, the heavy reliance on hydropower resources only occurs in the scenarios in which the expansion of transmission capacity is constrained. This implies that Switzerland could meet increased electricity demand through imports, but only when transmission capacities are expanded according to the 10YNDP.

Switzerland can develop a long-term dependency on high levels of electricity imports when electricity demand increases, as shown in Fig. 3.12. In fact, when Switzerland becomes dependent on imports to cover its production deficit pricing signals are not broadcasted to investors. Consequently, the de-rated capacity will be below peak demand, which poses a real threat to security of supply. However, when NTC expansions are limited at 7500 MW Switzerland initially increases its imports, after which scarcity signals are sent to the market as the NTC is inadequate to cover peak demands. On the long-term imports are reduced slightly compared to scenarios in which NTC is expanded according to the 10YNDP. However, generation capacity is expanded too late, and too slowly, resulting in high electricity prices in some scenarios. Limited evidence of boom-and-bust cycles can be observed when the NTC is limited at 7500 MW, as oversupply (Fig. 3.12, bottom right graph) follows a

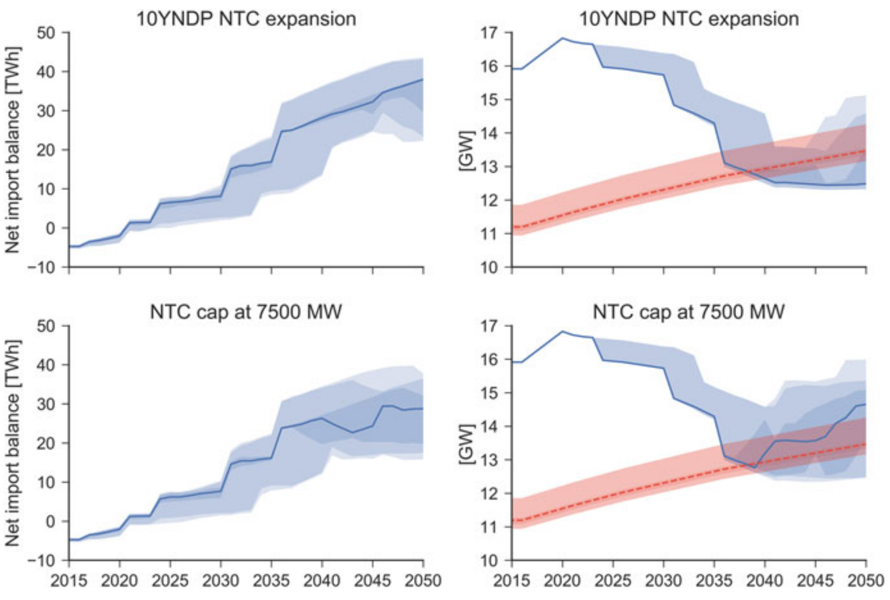

Fig. 3.12 Average yearly net import balance (left) and de-rated capacities and peak demand (right) over 3000 runs, represented by solid lines. The dashed line represents the modeled median peak demand. All graphs display simulation experiments under increasing electricity demand assumptions only

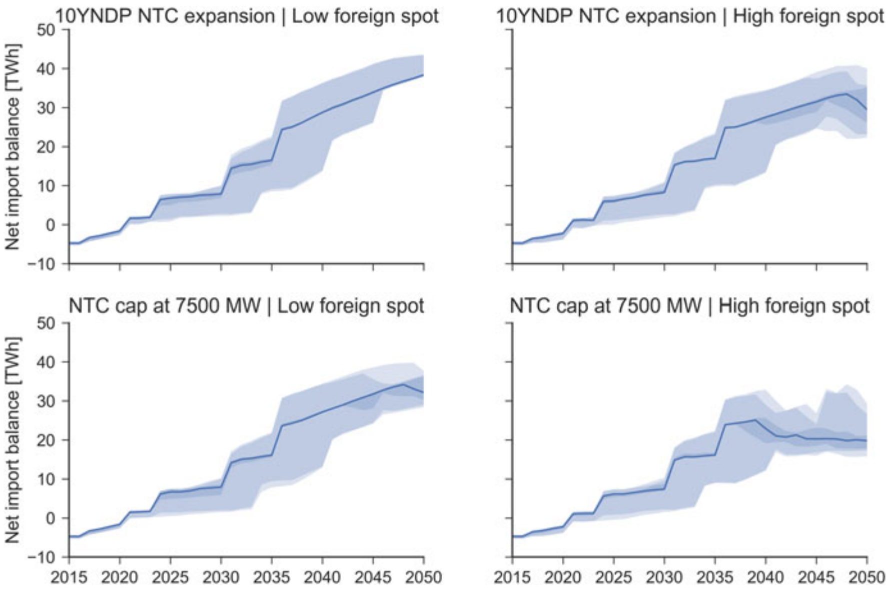

Fig. 3.13 Yearly net import balance over 3000 runs. All graphs display simulation experiments under increasing electricity demand assumptions only

period of undersupply after the last nuclear power plants are decommissioned and the French contracts have expired.

Foreign spot price developments have a large impact on electricity imports and exports (Fig. 3.13), significantly distorting market investment signals (Fig. 3.14). Lower foreign spot prices lead to a higher electricity import dependency, regardless of NTC expansions. However, due to low import prices the market is slower to respond to shortages as less hydropower is used to export to foreign markets. This highlights the interaction between foreign spot prices, electricity exports and hydropower as conceptualized in Fig. 3.4 by feedback loops (2) and (3). When NTCs are not expanded this can lead to more serious shortages and eventually higher domestic electricity prices (Fig. 3.15). As expected, price signals are suppressed and delayed in the scenarios in which large amounts of NTC are available. The 10YNDP expansion plans are sufficient for Switzerland to cover its import needs, assuming the electricity is physically obtainable from neighboring countries. This suppressing effect is amplified by the availability of cheap foreign electricity.

CCGT permitting time has a predictable impact on the installed de-rated capacity and domestic electricity prices. Once a shortage occurs, the market is less quick to respond with longer CCGT permitting times. Having established the influence of external factors on the operation of the Swiss market, we now turn to the influence of internal policies. Which endogenous policies help the market improve its performance and avoid scarcity pricing?

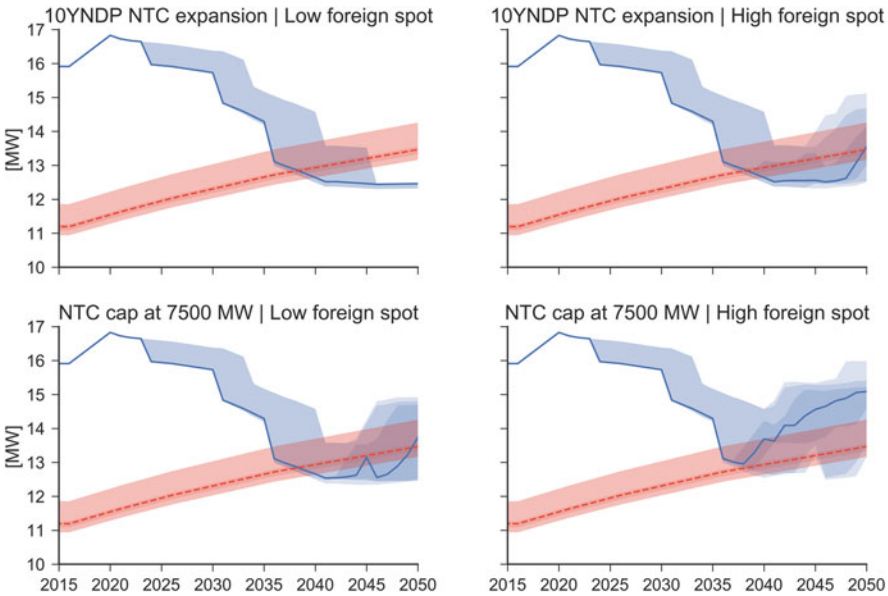

Fig. 3.14 De-rated capacity and peak demand. The solid line represents the modeled median de-rated capacity over 3000 runs. The dashed line represents the modeled median peak demand. All graphs display simulation experiments under increasing electricity demand assumptions only

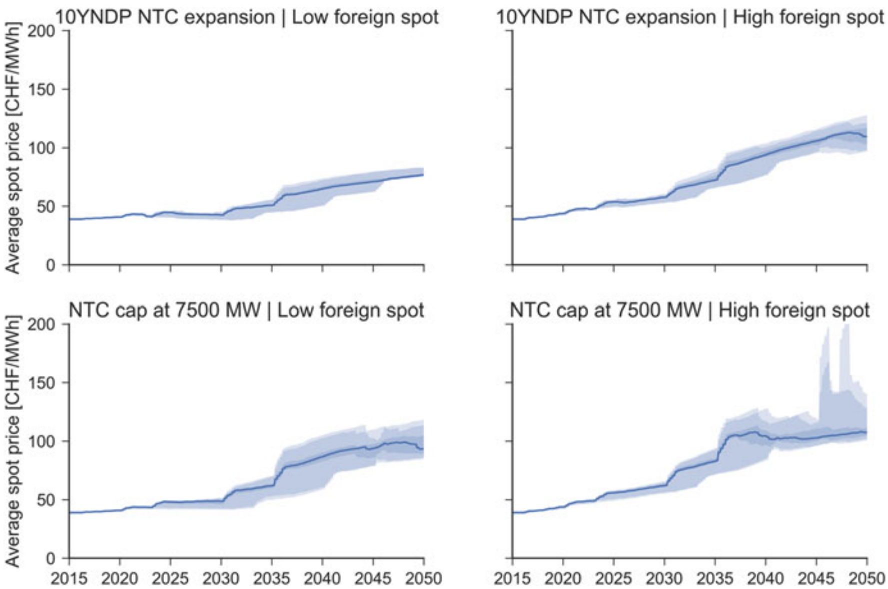

Fig. 3.15 Average Swiss electricity spot price over 3000 runs. All graphs display simulation experiments under increasing electricity demand assumptions only

As can be observed by comparing the first and second column of graphs in Fig. 3.16 NTC expansion has a significantly larger impact on electricity prices than any of the evaluated policies. However, Swiss domestic policies can make the difference when NTC expansions are limited at 7500 MW, compared to the business

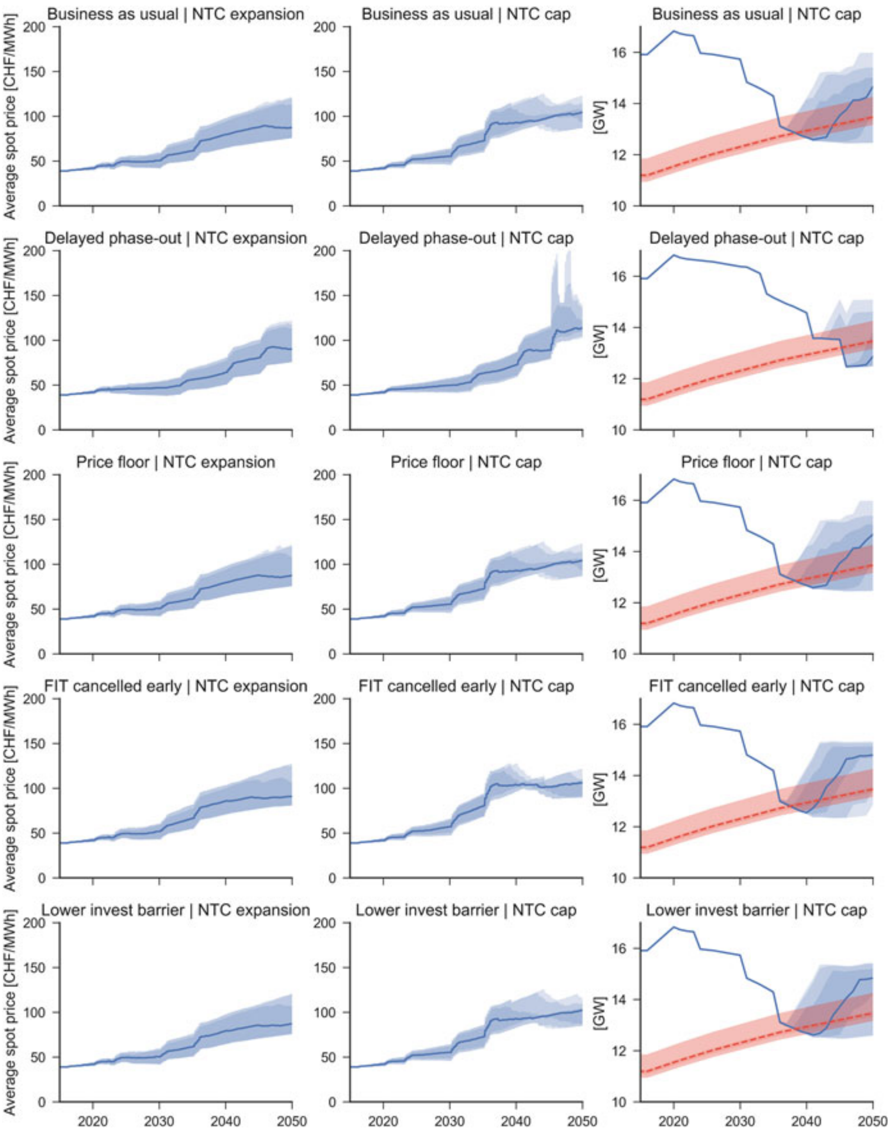

Fig. 3.16 Average Swiss electricity spot price (solid line) in columns one and two. The de-rated capacity (solid line) vs. peak demand (dashed line) in column three. All graphs display results over 3000 runs. All graphs display results under increasing electricity demand assumptions only

as usual scenario (top row of graphs in Fig. 3.16). In the following observations we only focus on the scenarios in which electricity demand is assumed to increase. First, a delayed nuclear phase-out (second row of graphs in Fig. 3.16) can lead to electricity shortage, as capacity investments are inadequate to meet peaks as demand continues to grow. The limited NTC available during the winter months is not sufficient to cover the electricity demand in Switzerland, leading to multiple years of scarcity pricing. Second, introducing a price floor (third row of graphs in Fig. 3.16) only has a minor impact in some cases, as it could help ensure the profitability of investments in generation capacity when spot prices are low. Third, an early cancellation of the FIT (fourth row of graphs in Fig. 3.16) increases the likelihood of an earlier shortage in supply when inadequate NTC is available. The acute shortage triggers a high level of investments, resulting in an oversupply in a majority of scenarios. It is unlikely that this will result in sustained boom-and-bust cycles, especially when the power plants replacing the phased-out nuclear power plants are much smaller in terms of installed capacity (e.g. solar, wind, CHP and CCGT). Finally, lower investment barriers (fifth row of graphs in Fig. 3.16) lead to earlier investments in installed capacity, lowering the chance of electricity shortages and price spikes.

To conclude, a clear trade-off exists between the risk of significant import dependency and that of electricity shortage. The optimal situation seems to lie somewhere between the large capacity expansions of the 10YNDP and the current levels of transmission capacity. Furthermore, artificial price signals such as a price floor can help secure a slightly higher level of investments, reducing the risk of undersupply. Renewable energy support schemes can have similar effects, but these simultaneously erode spot market prices through the merit order effect. There is little evidence of boom-and-bust investment cycles in most scenario combinations, especially in scenarios with low European electricity spot prices. On the other hand, higher foreign spot prices and limited availability of NTC can result in strong price signals and overinvestments. Importantly, the majority of scenarios lead to a lower security of supply, which is reflected by a de-rated capacity which is below the peak demand and an increase in the price volatility. Liberalized electricity markets commonly sustain lower levels of security of supply than regulated markets, which often have relatively high enforced targets. Thus, it is not unexpected to find decreasing security of supply levels after liberalization in Switzerland.

3.5 Conclusion and Discussion

Belgium, Germany and Switzerland have committed to phasing-out nuclear energy, while simultaneously maintaining low carbon emission levels. Additionally, Switzerland is facing the challenge of liberalizing its electricity market, which can lead to “boom-and-bust” investment cycles. Switzerland is in a period of electricity generation capacity overinvestment, resulting in a lack of investment signals for market players once the market is liberalized. Conversely, long delays between permit applications and the construction of power plants lead to overinvestments, as too many projects are initiated based on price signals during capacity shortage. Unique to the case of Switzerland is the combination of low European electricity spot prices, particularly in neighboring countries, and its large hydro storage capacity, which dampens domestic electricity prices and delays investment signals. In this chapter we have addressed the following research question: What is the impact of low European electricity prices on Swiss generation capacity investments under market liberalization and nuclear phase-out policies?

In order to answer this question, we have developed a novel SD model of the Swiss electricity market containing detailed endogenous investment pipelines, as well as bounded rational actors. This allowed us to explore the question of investment cycles in a liberalized hydro-dominated market which is going through a nuclear phase-out. Furthermore, we placed our study in the broader European context of low electricity prices and ongoing energy transitions. The practical contribution of this approach is that it allows us to explore future market developments under various policy options, taking into consideration the inherent system complexity and uncertainty over long time periods.

One of the key findings is that the period of overinvestment in Switzerland is most likely to be followed by a period of underinvestment. However, scarcity pricing does not always occur as the de-rated generation capacity falls below the peak demand. In fact, the price signal response by the spot market is often delayed, but can be quite severe.

The second key finding is that the electricity market is more often than not unable to address the capacity shortage under increasing electricity demand scenarios, leading to years of underinvestment in new generation capacity. Hydropower plays an important role in explaining the delayed market response, as it acts as a buffer for around 2 years. Once hydro reservoirs are depleted the shortage will be much more pronounced. Hydro reservoirs are depleted if there is insufficient NTC to import electricity during peak demand, and when companies export too much hydroelectricity. However, when transmission capacities are expanded it is very likely that Switzerland increases its import dependency, especially when European spot prices remain low. Consequently, investment signals will not broadcast and de-rated capacities will often remain below peak demand. Underinvestment will ultimately increase the price volatility in Switzerland. It was found that a clear trade-off exists between the risk of significant import dependency and that of electricity shortage. The optimal situation seems to lie somewhere between the large capacity expansions of the 10YNDP and the current levels of transmission capacity. Furthermore, artificial price signals such as a price floor can help secure a slightly higher level of investments, reducing the risk of undersupply. Renewable energy support schemes can have similar effects, but these simultaneously erode spot market prices through the merit order effect. Other policy options, such as a delayed nuclear phase-out and early cancellation of the FIT have a negative impact on the security of supply.

The theoretical contribution of this chapter is that we have found little evidence of boom-and-bust investment cycles in most scenario combinations, especially in scenarios with low European electricity spot prices. The phase-out of nuclear power and French contracts can quickly lead to low levels of security of supply, but there are a few unique characteristics of the Swiss electricity market which can protect it from scarcity pricing and boom-and-bust investment cycles. With these findings we pose a counter-example to earlier SD simulation work on boom-and-bust cycles (Ford 1999, 2001; Kadoya et al. 2005), and identify four key mechanisms contributing to the dynamics of investment cycles after market liberalization.

First, hydropower can act as a buffer for security of supply issues. However, reservoir storage capacities are limited compared to the annual electricity demand and reservoirs are drained quickly. While acting as a buffer the reservoirs also inhibit investment signals. Second, Switzerland has a relatively high NTC compared to its domestic electricity demand. Consequently, electricity can be important to cover peak demands. Third, the newly installed capacity is relatively small compared to the nuclear power plants which are being phased-out. As a result, future decommissioning of power plants will be more gradual, rather than large step-wise decommissioning of capacity. Fourth, the total installed capacity in Switzerland is relatively small compared to the size of nuclear power plants and even CCGT plants, resulting in a big change to electricity supply and prices after construction or decommissioning of a power plant.

There are several limitations to our analysis. First, the system boundaries are chosen in such a way that the neighboring countries are treated as exogenous, including investments in transmission capacity. Due to this limitation there is no feedback from the Swiss market to the foreign markets. While the Swiss market is relatively small compared to the German, Italian and French markets, it is likely that the endogenous investments in transmission capacity would more accurately capture impacts on electricity flows and spot prices between these countries. Second, SD does not allow for a very detailed dispatch model of individual power plants, including ramping constraints and individual marginal production costs. Other modeling and simulation paradigms, such as optimization approaches and agent-based modeling, are well-equipped to include such details in the model, leading to more realistic spot prices. Third, a time horizon until 2050 does not allow for multiple boom-and-bust cycles to be observed, as the full phase-out is not completed before 2034. However, longer time horizons are also inherently more uncertain.

We recommend multiple venues for future research. First, capacity remuneration mechanisms can be used to dampen investment cycles (Ford 1999) and are currently being implemented in countries around Switzerland (Betz et al. 2015). Modeling the implementation of a capacity mechanism for Switzerland, and its interaction with neighboring markets, will give more insights into policy options to address the challenges of transitioning to a liberalized market and avoiding security of supply issues. Second, implementing endogenous transmission capacity investments can address congestion issues in the model and potentially address the trade-off between import reliance and capacity shortage found in our scenarios. Third, neighboring markets should be modeled in more detail to consider the impact and feedback of foreign policies, foreign demand and supply at the hourly level. This would allow for the exploration of high RES penetration scenarios and the evaluation whether electricity is physically available during peak hours when relying on imports. As demonstrated by Jäger et al. (2009) and Kunsch and Friesewinkel (2014) the model and methodology used in this chapter can be applied to other countries phasing-out their nuclear energy supply, such as Belgium and Germany. Fourth, demand profiles are currently static and based on historic values. However, such profiles are likely to change due to the adoption of e-mobility, heat pumps and demand response.

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4 Effectiveness of Regulation: An Investigation of the Turkish Natural Gas Distribution Market

Okan Yardimci and Mehmet Baha Karan

Abstract

In this chapter, the effectiveness of regulation in the Turkish natural gas distribution sector is investigated by examining EMRA's implementations and the performances of the companies. The analyses were taken into account mainly in the context of the effectiveness of regulation rather than in drawing conclusions with respect to economic paradigms, like market failure. The important regulations with regard to the Turkish natural gas distribution sector were analyzed within the scope of the differences between the various planned and recognized situations. Thus, it was understood that some of the regulations did not produce effective results. Particularly the comparison between private and state-owned companies concerning their performances and R&D expenditures revealed the alienation experienced from the expected benefits of liberalization. The regulations to encourage sector development and cost reduction through R&Ds have not been properly implemented. The obtained results are considered as partially regulatory failure.

Keywords

Natural gas · Distribution · Natural monopoly · Effective regulation · Regulatory failure

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4.1 Introduction

According to today's generally accepted economic approach governments aim to reduce the production function of goods and services, to create multi-player markets for appropriate fields of activity, to increase efficiency and service quality, and to innovate approaches in a positive way. On the other hand, the fact that perfect competition conditions are not fully achieved in practice may lead to "market failure" when the markets are left to themselves. This situation leads to the need for "government intervention." In some fields the most efficient production of goods or services can be carried out by a single company and this makes government intervention necessary from the beginning. These special fields that need to be "regulated" intrinsically are called as "natural monopolies".

In the early periods of the regulatory economy, governments have implemented some kind of interventions with their own bodies. The necessity of establishing independent administrative authorities had appeared over time. These administrations are often expressed as "regulatory authority." The requirement of such an independent body, based on the need for decision-making without political influence, has become even more evident from time to time due to difficult tasks such as taking an intermediary role in public-private disputes. The way in which the regulator's budget is formed from licenses and similar incomes received from market players support financial independence of the authority, while guaranteeing the executives' positions ensures the administrative independence.

In the past years, the ineffectiveness of the economy appeared as a result of government intervention has been identified as "government failure." With the increasing function of independent administrative authorities, "regulatory failure" concept has been included to the literature. The effectiveness of any application of the chosen government should be assessed according to the differences between the planned and the actual implementation. Undoubtedly, the effectiveness of government or in other words government failure is highly subjective and often debated. On the other hand, the detection of regulatory failure can be more evident. The planned situation for the regulatory authority is to reach the targets set by political actors and these targets are written in law. If the objectives of the regulatory authorities, which are governed by laws cannot be achieved within predetermined time interval, there may be a regulatory failure and there may be some reflections on the government success or government failure according to the government's role in that success or failure. "Effectiveness of regulation" has great importance on the success of the regulatory body.

Even though there have been several studies (such as Datta-Chaudhuri 1990; Le Grand 1991; Winston 2007) examining government failure or market failure in different countries, the number of studies regarding to the regulatory failure or effectiveness of regulation is limited since the regulatory authorities have been actively involved in the administration of most of the countries, especially the European ones, in the recent years. Instead of direct investigation or focus on the effectiveness of regulation, most of the researchers analyzed the results of liberalization process which means the combination of market, government and regulatory failure or effectiveness. For instance, Sant Ana et al. (2009) concluded that possible surplus in the natural gas sector, non-discriminatory open access, information transparency and tariff are the key factors in order to achieve the expected results of the liberalization process in the Brazilian gas industry. Another study found that legal and institutional conditions and the initial market structure of each European Union Member State are also important for the results of the liberalization (Slaba et al. 2013). Capece et al. (2010) focused on the chances in performance in the Italian natural gas retail market by analyzing the profit and financial position of the companies concerned over the first 3 years following the market liberalization and the results of the analysis showed that the majority of companies attained a high level of performance. Andrade (2014) carried out an empirical analysis using a panel data of 11 European countries from 2001 to 2011 in order to measure the performance of the regulated segments such as transmission and distribution. The studies on Turkish electricity market is highly limited. Çetin and Oğuz (2007) focused on the reasons for the slowdown in the Turkish electricity market reforms and concluded that the institutional and political structure had not been ready for creating an efficiently working competition and absence of an independent regulatory agency had been one of the main reasons for this failure. The same authors also evaluated the reforms in the Turkish natural gas market and concluded that reforms had not worked out as expected. On the other hand, Akkemik and Oğuz (2011) focused on the results of the reforms in Turkish electricity market and founded that enhanced efficiency in the electricity sector was achieved and this caused reduced household energy prices, and gains in output and welfare by 0.5–1.1% of GDP. In this studies market, government and regulatory failure or effectiveness were not separated and instead of that the results of liberalization process were evaluated as the combination of all of the elements.

In addition to the above studies, some of the researchers specifically focused on the effectiveness of regulation especially for the US market by differing the regulatory failure from market failure or government failure. As an example, in Moore (1970) the effectiveness of electric utility prices was analyzed for the US market. Some other studies analyzed the impacts of the deregulation process on the US energy market in the context of regulatory failure/effectiveness (Joskow et al. 1989; Dempsey 1989).

The purpose of this study is to examine the regulatory effectiveness of the Turkish natural gas distribution sector, which has been privatized since 2001. In this framework, the hypothesis *"effectiveness of regulation has been achieved in the Turkish natural gas distribution sector"* is tested. To the best of our knowledge, this is the first study to examine the effectiveness of regulation in Turkey. Effectiveness of regulation in the Turkish natural gas distribution sector was investigated via examination of some important regulatory implementations. Negative and positive indications of the regulations were listed by linking the elements of the effectiveness of regulation. In addition to that, impacts of the regulatory applications on the sectoral performances were examined for a comprehensive analysis. Financial and regulatory tables of the distribution companies had been obtained from the regulatory authority and these data were used together with the legislation and the other information provided by the agency's website.

In the second part of this study, Turkish natural gas distribution sector is introduced briefly. Theoretical background is presented in the third chapter and this information has great importance in terms of evaluating the regulatory implementations in the Turkish natural gas distribution sector and the performances of the companies. Fourth part of the study starts with a brief methodology subsection and continues with the evaluations of the regulations in the Turkish natural gas distribution sector. In this part of the study, the existence of the elements mentioned in the third section has been researched within the scope of the applications towards the Turkish natural gas distribution sector. In addition to that, impacts of the regulatory applications on the sectoral performance has been analyzed. The study has been completed with the summary and conclusion section summarizing the findings obtained in all the data presented in the first four sections.

4.2 Turkish Natural Gas Distribution Sector

The laws enacted in 2001 within the framework of the privatization and liberalization brought major structural changes in the electricity and natural gas sectors of Turkey. In this context, the Energy Market Regulatory Authority (EMRA) has been adopted as an independent administrative authority assigned to "regulate" and "supervise" the energy market. The structural reform has occurred in the Turkish natural gas sector at the beginning of the twenty-first century with the influence of reform in Europe and the guidance of some foreign institutions. The Natural Gas Market Law ("Law"), which was adopted on April 18, 2001, aimed to provide competition in the wholesale market and for this reason to unbundle the market activities, and separate the vertical integrated structure of the state-giant company, BOTAŞ. The law considered natural gas transmission, distribution and storage activities[1] as natural monopoly areas (Law 2001). The similar results produced by the competitive environment can be produced by only through effective regulation in these specific areas. EMRA has played an important role in the restructuring of the natural gas sector. Market activities have been separated, state-owned companies have been unbundled and private companies have been involved in the natural gas sector.

The law aimed to widen the natural gas usage throughout the country. Only seven companies[2] were operating in six provinces before the Law. Six of which were state-owned and only one of them was a private company. The objective set forth by the political authority for the widening of the natural gas usage has been achieved through natural gas distribution tenders. After the Law, 62 tenders were completed and natural gas became widespread throughout the country by the private

[1]If the storage capacity is insufficient.

[2]These companies will be named as 'existing companies' in the following parts of the study.

distribution companies. At present, 69 companies are operating in 77 provinces and 68 of them are private companies.[3] Five of the existing companies were transferred to the private sector so there is no distribution company operating in public ownership other than İGDAŞ.[4]

Natural gas distribution companies in Turkey are “natural monopolies” in the regions where they operate. Natural monopoly is the case when the repetition of the network within the same geographical area is inefficient (Gomez and Rivier 2000). In natural monopolies, fixed costs are quite high compared to variable costs. In this case, which is usually seen in the networking industry, the investment of more than one company may result in the ineffective use of the networks. On the other hand, in natural monopolies, it is only possible to expect companies to behave as if they are in competition with the enforcement of the effective regulation.

In natural monopolies, granting a “concession” to a company can be done in a variety of ways. The Chadwick-Demsetz tender method is adopted in Turkey’s natural gas distribution sector. It solves the competition problem of companies that want to operate in the natural monopoly field through tendering/competition. The basis of the approach can be summarized as “competition for the field” instead of “competition within the field” (Chadwick 1859). However, Demsetz (1968, p. 64) considered some problems such as “the problem of windfalls”[5] during the application of the Chadwick’s method. He (p. 65) emphasized the necessity of distinguishing the unexpected loss/gain problem with the “problem of forecastable rents” which is a kind of predictability problem because of the investors’ proposals. This is a very difficult task for most of the regulatory authorities who performed this kind of auctions for concessions. A study analyzed the possible reasons for extremely high concession fees for the Italian distribution sector and evaluated their possible impact on companies’ profitability and a solution was proposed in order to build an effective regulatory framework in which competition for the field could actually lead to the market efficiency (Dorigoni and Portatadino 2009).

In general, companies participating in the tender of the Turkish natural gas distribution sector compete to be able to carry out distribution activities in the cheapest way during the first 8 years and the winners of each tender are obliged to complete the network construction within 5 years. Because competition was intense in tenders, distribution fees have dropped to very low levels and in many regions, sometimes reaching to “zero”. Later the companies continued to compete by discounting the Subscriber Fee (aka: Connection Fee), which includes the cost of connecting the subscriber, for a period of 5 years. In a region, this fee was also reduced to “zero” and the company that paid the maximum license fee won the competition.

The number of firms interested in the tenders in the first period (Fig. 4.1) were high and caused a considerable decrease in the distribution fees in the fixed tariff

[3] The companies that have endorsed license by a tender will be named as ‘tendered companies’ in this study.

[4] Istanbul Natural Gas Distribution Company

[5] According to Demsetz it can be positive windfall or negative windfall.

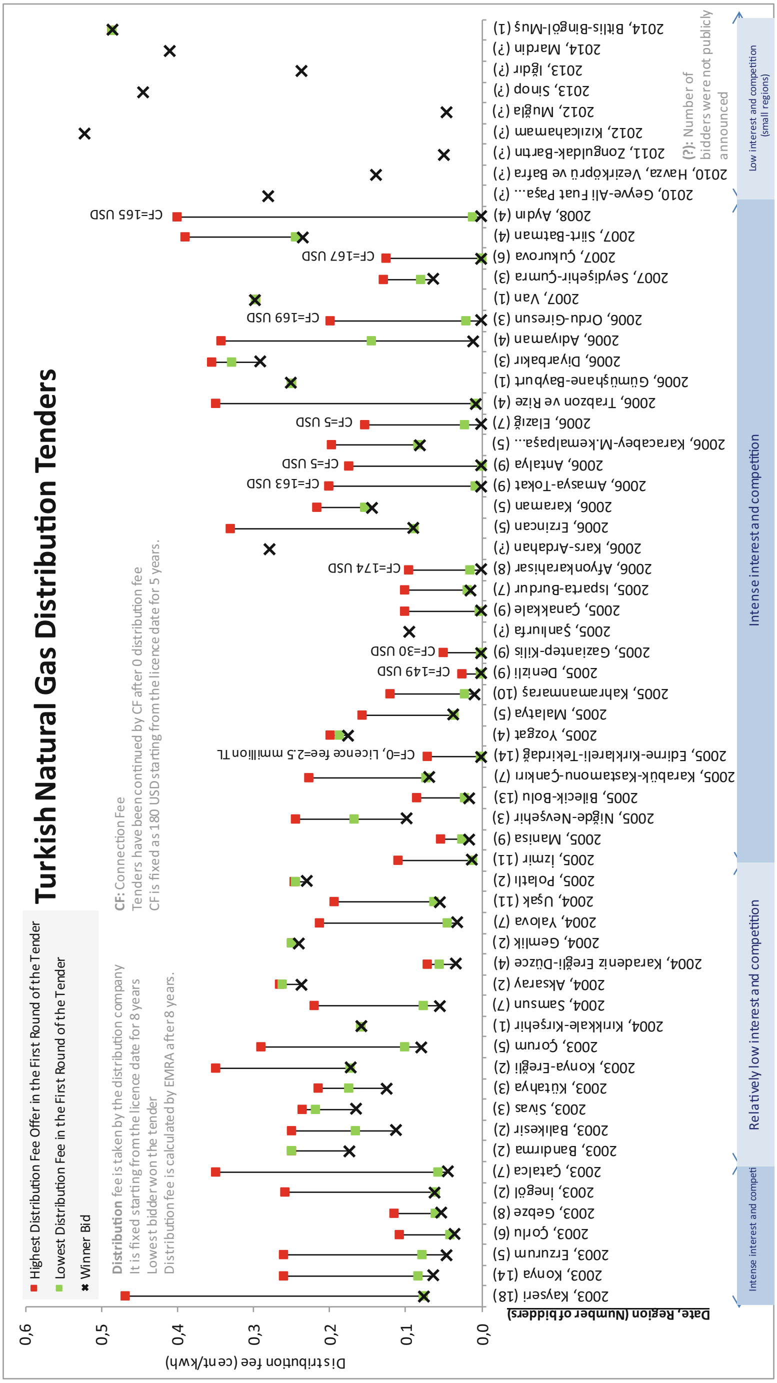

Fig. 4.1 Turkish natural gas distribution tenders (source of data: tender results-EMRA website)

term, 8 years of period. In the second period, relatively low interest and competition were observed. It can be noticed that there was an intense interest and competition for tenders in the third period. Finally, tendered regions were relatively small in the last period.

The tariffs to be implemented by the tendered companies for the first 8 years from the date of obtaining the license were determined during the auction and the tariffs are set by EMRA at the end of 8 years (also named as fixed tariff period in this study). Tariffs are determined by EMRA by using the "price cap" method after 8 years. Determined tariffs will be evaluated in a detail in the fourth section of the study.

4.3 Theoretical Approach to Measure the Effectiveness of Regulations

4.3.1 Background

There are significant differences in the main economic approaches to the fields of "competition" and "regulation." Discussions on these concepts have continued since Adam Smith, founder of the Classical Economics Theory, which is considered to be the beginning of the modern period economics. According to this theory, "state intervention" is not necessary because perfect competition reaches "allocative efficiency" and provides "social welfare" at the highest level (Smith 1776). The "invisible hand" enables the market to find its own truth. The most important criticism to classical economists is that it is not practically possible to achieve perfect competition conditions. It is believed that "Pareto efficiency"[6] cannot be achieved in practice because of the lack of perfect competition. Moreover, it is uncertain how to get ahead of monopolization when there is no perfect competition. If the market cannot produce effective results, "market failure" will appear.

The development of the concepts of "regulation" and "competition" have occurred mainly in the periods when the Keynesian approach and the Neoliberal approach were accepted. Keynes did not accept the Principle of Classical Economy "laissez faire." The Keynesian Theory, which was widely accepted from 1929 to 1980, reveals the need for the state to actively regulate. Keynes suggested a course of action, on the contrary of leaving it "as it is": The state should take more active role, not just in private sector, but in reducing uncertainties outside the economy

[6] The "Pareto efficiency", taken the name from the famous Italian economist Vilfredo Pareto, can be described as the highest level of efficiency where it is not possible to improve the condition of someone else without worsening the condition of any one. Nobel prize-winning economist Joseph Stiglitz explains the "Pareto activity" as follows: "... the 'Pareto activity' is provided only when there is no chance of improving his situation without deteriorating the situation of anyone else" (Stiglitz 2009; p. 11).

(Bernstein 2010; p. 257). Keynesian Theories' greatest innovation has been to put forth the necessity of state intervention called "regulation" because of the lack of a perfect competition environment. It is possible to define regulation in the form of all interventions that change the direction in which the market is behaving (Stiglitz 2009; p. 22).

The petroleum crisis of the 1970s and the subsequent increase in energy prices have resulted in increasing doubts to the Keynesian approach especially in the US and the UK. In the neoliberal approach, there is a stance against Keynesian interventionism in the framework of regulation. For this reason, "liberalization" tendencies have gained more importance in today's accepted market model. The privatization and liberalization tendency, which started in the 1980s, also affected the energy sector and started to break the market dominance of the state-owned companies operating in the energy sector in the UK and in some of the European Union countries in the 1990s. On the other hand, many countries are positioned in the energy field differently due to the strategic importance. Some European countries continue to protect the state-owned energy giants and allow them to operate in all areas of energy within a vertically integrated structure. In recent years, there have been increasing questions about whether economic approaches are feasible for each sector. Energy was at the forefront of these areas.

The concept of "regulatory failure" has emerged in recent years when regulatory authorities have been actively involved in the administration of the state. In the past periods, the failed intervention was called as "state failure". Nowadays it is expressed as "government failure" or "regulatory failure" according to the government's role in the failure. Shortly, regulatory failure can be summarized as the failure of the regulatory authority to reach the political preferences which are specified in the law.

4.3.2 External Factors

In some cases, the political authority directs the regulator to the wrong path. It is not fair to talk about the success of the regulator in these cases since the goal function was drawn wrongly. An important assumption in this framework is that the "liberal market model in the natural gas distribution sector", as set by the political authority, has ability "to provide natural gas to the consumers in a quality, continuous, cheap and environmentally friendly manner".[7] In this study, "government failure" or "market failure" is not addressed in detail.

It is expected that a regulatory authority should be able to decide based on its own authority and responsibilities within the law-drawn area independently. Indeed, this is one of the main purpose of the establishment of the regulatory authorities. In this

[7]This is the goal of the Natural Gas Market Law expressed in the Article 1.

respect, it is important for administrators to be protected by a duty guarantee for not being exposed to political repression, to clarify their positions in the state with a constitutional definition, to provide their budget by market players, and to ensure administrative and financial independence. On the other hand, it can be considered that the full independence of the regulatory authorities is a utopia, similar to "perfect competition environment" in a market model.

In addition to the erroneous determination of the "objective function" for the regulatory authority, the pressure placed on the regulatory authority by the government, incompetent management or some other external factors such as court interventions can be another cause of a regulatory failure.

According to the National Regulatory Research Institution (NRRI) "an effective regulator is necessary for effective regulation" (NRRI 2009; p. 5). NRRI has identified four features of the effective regulator as: purposeful, educated, independent, and determined. The government's long-term irrational behavior, and its focus on election and other short-term events, may lead to a regulatory failure. Regulating in harmony with the political authority should not be prevailed over protecting the interests of the people in the middle and long term. The powers and responsibilities between the political authority and the regulatory authority need to be clearly defined. In addition to ensuring success at the managerial level, it is also important to ensure the best selection and the effective use of the expert staff. Moreover, incomes of the staff should be appropriate for the size/importance of the work done. Another intervention similar to the government intervention that can cause a regulatory failure is the intervention by the courts. It can be seen that all the improvements that regulatory authorities have succeeded can be disrupted by court decisions from time to time (Viscusi et al. 2005; p. 9).

4.3.3 Measurement of the Effectiveness of Regulation

In this study, regulatory success was assessed in the direction of the regulator's own decisions. In this framework, it is thought that the objective function that can be used in measuring the "regulatory effectiveness" is clearly written in the aim part (Article 1) of the Law, which is determined by political authority. Within the scope of regulatory effectiveness, the existence of the following elements has been researched:

(a) One of the preconditions for regulatory effectiveness is a successful **Regulatory Impact Analysis** (RIA). RIA refers to an ex-ante measure of the regulation where measuring the effectiveness of regulation is the ex-post form of it.
(b) An important factor that can lead to "regulatory failure" is "**regulatory capture**". The advantage that the regulated company may obtain by the "regulatory capture" can often be at very high levels. The founder of "capture theory" is

regarded as Stigler because of the article he wrote in 1971 (Stigler 1971; p. 5–6). Stigler's general hypothesis is that all industries or areas with sufficient political power will try to control market entry through the state. In addition, even in industries that have managed to control penetration into the market, price controls will be required through repressive forces. Regulatory capture can constitute a major obstacle to effective regulation. One of the most commonly used tools to dominate the agency is the lobbying activities.[8] Companies' information about the regulation system and their power on the regulatory authority are much more than the consumers. The relationship between capital and politics can be another factor that facilitates the regulatory capture. This problem is more evident in the United Stated especially considering the financing of politics based on direct donations.

(c) There is also an **information asymmetry** between the regulated company and the regulatory authority, and it is not possible to perform effective regulation when the information asymmetry is high. Theoretically it is possible to reduce the information asymmetry to zero but in practice it is not possible to get rid of it completely. Moreover, the regulation costs to reduce information asymmetry should also be assessed critically since these kinds of transaction costs are reducing the social welfare or in other words total surplus.

(d) **The Averch-Johnson effect** (aka A-J effect) implies that firms may use excessive capital to increase their profits and this is one of the indicators of regulatory failure. The most important reason of the A-J effect is the determination of reasonable rate of return highly relative to the real cost of capital (Averch and Johnson 1962; p. 1053). Averch and Johnson also mentioned about the indirect effects of high rate of return to the other markets. Having a significant advantage in the regulated market by a financial support can cause the competitive environment even more disruptive in the unregulated areas because of the predatory price-cutting (Averch and Johnson 1962; p. 1058). In addition to that, the use of high quality/expensive materials, also referred as "**gold-plating**", should be carefully monitored. Gold plating is also seen as one of the most important reasons for the inefficiency of unregulated monopoly structures (Energy Charter Secretariat 2002; p. 24). This term is generally used for material costs, but it also can be used to cover a wide range of inefficiencies including unnecessary staff. In order to avoid this issue, it is very important to establish a tariff structure that works in line with market-based pricing principles.

[8]Assuming that the annual income to be obtained by the company in the framework of the regulation economy is 100 million USD and that company can increase its income to 100 million + B amount by spending A amount of money for lobbying. The company will try to realize all situations where A is smaller than B. This is a rational behavior for a company that only acts to maximize its profit. The regulated company may also try illegal ways as well as the above legal way. Undoubtedly, in such a case, the cost of catching and the risk of catching have to be included in the calculation.

(e) Another factor that could lead to regulatory failure is the creation of "**too big to fail**". The failure of too big companies, due to their sizes, has become a significant risk for the economy in general terms. Stiglitz defines this as "American style socialism" and criticizes the privatization of earnings and the socialization of losses (Stiglitz 2009; p. 19). Regulatory authority may also try to prevent the whole industry from collapsing. In some circumstances sector players may go to cartel formation for this purpose. In its simplest terms, the cartel is an association formed by companies acting in coordination to maximize profit (Carlton and Perloff 2015; p. 32).

(f) The "**free riders problem**", which is defined as consumers' not paying for the cost of the product they use and the cost they create, is another indication of regulatory failure. An example of this is the lack of the habit of using tickets in public transport in some of the Eastern European Countries. Generally, services such as electricity, water, education, health, communication are regarded as universal services and it is expected that the state should deliver these services even if the investment is not feasible. The free riders problem can also arise from subsidies among different consumer groups. Subsidies between different consumer groups can be avoided only through effective regulation. Special regulations should be implemented for "vulnerable consumers" who have difficulty paying the bills.

(g) **Transparency** is important both in terms of productivity growth and justice in resource allocation (aka: allocative efficiency). A consumer should be able to see the costs spent for him/her. In this way, there will be pressure not only on the companies but also on the regulatory authority. This is an important right of the consumer who pays the production costs created by the company and the transaction costs created by the regulatory authority. In some of the countries regulatory agencies announces the comparison of the companies publicly. This kind of applications can create a public pressure on poor operators (Fulwood 2006; s. 25).

(h) Delays due to regulatory actions (aka: **regulatory lag**) may lead to "regulator failure". As an example, in a situation where entry to the market is blocked for any reason, a regulatory authority that has not been aware of it may have created a significant advantage over existing companies on the market for a certain period of time. **Regulatory evasion** (aka: **regulatory arbitrage**) should be avoided.

In this study, the existence of the above-mentioned arguments (a–h) has been researched for the Turkish natural gas distribution sector. Following the evaluations on regulatory practices based on the above elements in Sect. 4.4.2.1. Performances of distribution companies, public-private comparison, R&D expenditures are examined in another Sect. 4.4.2.2, of the study.

4.4 Effectiveness of Regulations in the Turkish Natural Gas Distribution Market

4.4.1 Data and Methodology

In this section, secondary legislation and licensing procedures, privatizations and natural gas distribution license tenders, tariffs and other applications in the Turkish natural gas distribution sector have been dealt in detail in terms of "regulatory effectiveness". Regulatory applications are given in a historically classified way in Sect. 4.4.2.1 and the elements of effectiveness of regulation mentioned in Sect. 4.3.3 are evaluated in parallel with the historical explanation of the applications. In summary, all the findings are listed in a table at the end of the Sect. 4.4.2.1 of the study.

In addition to that, impacts of regulatory applications on the sectoral performances, including sub-topics such as public-private ownership comparison and R&D expenditures have been evaluated in Sect. 4.4.2.2. Moreover, an empirical study on efficiency and service quality has been given in this subsection of the study. These evaluations are used to support the results obtained in Sect. 4.4.2.1 in order to test the hypothesis.

Financial tables, regulatory tables, legislation regarding the Turkish natural gas distribution sector and some other information such as distribution tender results are used for the evaluations. Financial tables and regulatory tables of the distribution companies had been obtained from the regulatory authority whereas the other data/ information had been obtained from the agency's website.

4.4.2 Findings

4.4.2.1 Evaluations of the Regulatory Applications

Within the scope of establishing secondary legislation for the natural gas distribution sector, several Regulations, Communiqués and Board Decisions have been issued by EMRA since 2001. Secondary legislation is thought to be appropriate in terms of quantity (it is not evaluated in terms of content/quality here). On the other hand, **RIA** was not observed for the secondary legislation and in this respect ex-ante measurement of the regulations were not implemented effectively.

Regulations and Procedural Principles prepared by EMRA and the amendments in this scope have been opened for consultation on the web page of the agency for at least 1 month and finalized in line with the opinions received from the market. This situation has great importance on "**transparency**". Meetings and workshops with the sector were helpful for the legislative arrangements. On the other hand, consumers' contributions or evaluations have not been adequately received. In operation, this inequality has been tried to be balanced by the staff of the agency. Along with these evaluations, it is thought that increasing the **transparency** of the Board meetings by live broadcasting and sharing the opposing votes and reasons against the decisions in detail with the public can provide some improvements.

Establishment of important standards in the technical aspects of the natural gas distribution sector has been completed generally by the secondary legislation. On the other hand, it is thought that explanatory regulations for a number of critical areas could not be completed in time. The fact that detailed arrangements for some issues that need to be determined before "distribution tenders" could not be realized have caused major problems and can be expressed as **regulatory lag**.

EMRA, in general, has successfully implemented licensing processes in the natural gas sector. The problems experienced in the oil or electricity sectors are not seen in the natural gas sector with regard to the licensing issue.

In the processes for the privatization of the existing distribution companies, EMRA performed a number of regulations. In this kind of transactions, it is important to clarify some critical issues before privatization. In this context, it is possible to talk about the regulatory effectiveness especially for the last distribution privatization, BAŞKENTGAZ.[9] On the other hand, some uncertainties during the previous share transfer and privatization processes led to various court actions.

The objective set forth by the political authority for the dissemination of natural gas has been achieved through natural gas distribution tenders. Chadwick—Demsetz method that was mentioned in the previous sections has been applied in the Turkish natural gas distribution sector. At this point, it is useful to underline that the issue is handled within the framework of "regulatory failure" rather than "market failure" or "government failure". As it was mentioned before, it is possible to talk about an effective regulation for the dissemination of natural gas, while not considering the goal function is right or wrong.

The first 8-year period in which the low prices applied because of the competition in the tender is the period that purest form of price cap method is applied. Starting from 2012, companies are moving one by one to the tariff implementation period under the tariff methodology of EMRA. The biggest criticism of the natural gas distribution tender that it is not clarified sufficiently as to how to determine the distribution prices at the end of the 8 year before the auctions.

When the tariff applications are examined at the end of the 8th year:

- it is found that the tariff period determined as 5 years and this period is reasonable;
- the period of depreciation considered as 22 years is not so short as to cause a significant problem and
- the Reasonable Rate of Return which was determined as 11.83% for the period of 2012–2016 and 12.85% for the period of 2017–2021 are high and can cause "**A-J effect**".

In the level of creating the "Regulated Asset Base", it is seen that in the tariff methodology, many incentives are taking place in order to provide sustainability of a sector that has taken great "risks" during the tender. Regulations and incentives for

[9] A distribution company that operates in the capital city of Turkey, Ankara.

ensuring the sustainability of the sector show that the problem of "**too big to fail**" in the natural gas distribution sector has occurred. Regulatory authorities sometimes experience this problem on a sector basis rather than on a company basis. Extra incentives to the sector can be seen in order to prevent the collapse of a sector that may affect the general economic situation. The fact that a majority of the regulations are against consumers can also lead to the problem of "**regulatory capture**".

It is seen that the tariffs have been increased significantly compared to the auction period. Ratchet effect[10] is seen in the market after tender period, 8 years fixed term (Fig. 4.2).

As it is seen in Fig. 4.2, distribution fees for household consumers were increased notably. It increased to a level even higher than the highest tender offer (Fig. 4.1) in the first round of the tender. Changes of distribution fees for all consumer groups are shown in Table 4.1 in a detail.

Single fee that had been applied during the tender period (first 8 years) are listed in the last column. The **free riders problem** arisen from subsidies among different consumer groups.[11] As it was mentioned before, distribution fees were determined by EMRA, according to the consumption level of the consumers, after the 8 years of the license date. Yellow marks show the increase of the tariff after 8 years. Tariffs have been increased in all distribution regions for the household consumers and in most of the distribution regions for the other consumer groups. The subsidization continues in most of the distribution regions after 8 years period. On the other hand, number/amount of unpaid bills were not very high.

There has been no significant **regulatory lag** in setting tariffs. Nevertheless, an effective study on "vulnerable consumers" in the natural gas sector has not been carried out yet.

The regulatory account plan published by EMRA is particularly important at the point where the tariff design can be made smoothly and this is very important in terms of **information asymmetry**.

It is seen that EMRA is trying to bring certain standards to the service quality in the natural gas distribution sector with the legislation. On the other hand, detailed studies should be carried out in order to reduce the number of complaints, terminate the complaint within a certain period of time, shorten the deadlines for invoice appeals, eliminate the troubles experienced in the reimbursement of the guarantee amount, increase online transaction capability, decrease gas opening-closing times. **Information asymmetry** is a big concern since the data are generally obtained from distribution companies for the service quality studies.

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[10]Ratchet effect has a broader meaning as an instance of the restrained ability of human processes to be reversed once a specific thing has happened such as a tendency of people to be influenced by the previous highest level of a factor. In the economics of regulation context, it means hiding or abolishing the efficiency increase by the regulated company in order to survive a disadvantage in the future tariff implementation period.

[11]In a negative way for big consumers in all distribution regions during 8-year period, fixed term. See Table 4.1 for detail.

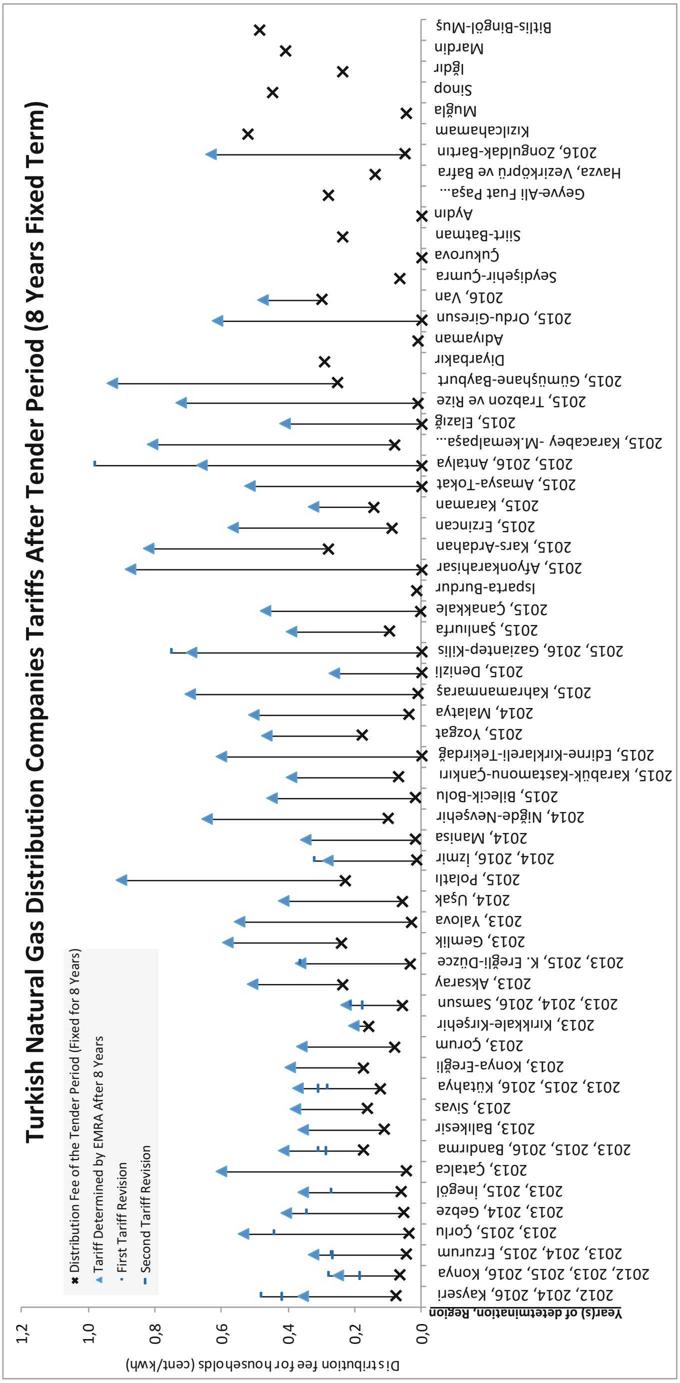

Fig. 4.2 Increase of the Turkish natural gas distribution tariffs after tender period (source of data: board decisions-EMRA website)

Table 4.1 Changes of distribution fees for all consumer groups (source of data: board decisions-EMRA website)

2015, September	Distribution Fee Determined By EMRA After 8 Years						Tender Fee
Name of the Distribution Company	0 -10.000 metercube (households)	10.000 - 100.000 metercube	100.000 - 1.000.000 metercube	1.000.000 - 10.000.000 metercube	10.000.000 - 100.000.000 metercube	Above 100.000.000 metercube	Single Fee TL/metercube
2012, 2014, Kayseri	0.116147	0.116147	0.053764	0.042229	0.028119	0.028119	0.022385
2012, 2013, 2015, Konya	0.054532	0.054532	0.027570	0.024163	0.024163	0.024163	0.018850
2013, 2014, Erzurum	0.069141	0.069141	0.069141	0.069141	0.069141	0.069141	0.013549
2013, 2015, Çorlu	0.126886	0.126886	0.067717	0.067717	0.048296	0.048296	0.010603
2013, 2014, Gebze	0.088048	0.088048	0.032377	0.032377	0.025052	0.005055	0.015316
2013, 2015, İnegöl	0.076800	0.076800	0.022838	0.022838	0.022838	0.022838	0.017967
2013, Çatalca	0.137845	0.137845	0.040414	0.040414	0.040414	0.040414	0.012960
2013, 2015, Bandırma	0.088923	0.088923	0.039606	0.039606	0.039606	0.001066	0.051249
2013, Balıkesir	0.081598	0.081598	0.039457	0.025871	0.025871	0.025871	0.032988
2013, Sivas	0.086605	0.086605	0.063371	0.038474	0.029884	0.029884	0.048304
2013, 2015, Kütahya	0.079707	0.079707	0.024506	0.024506	0.024506	0.024506	0.036523
2013, Konya-Ereğli	0.094587	0.094587	0.029181	0.029181	0.048209	0.048209	0.050660
2013, Çorum	0.082085	0.082085	0.028151	0.028151	0.016584	0.016584	0.023268
2013, Kırıkkale-Kırşehir	0.050106	0.050106	0.024068	0.024068	0.015369	0.015369	0.046537
2013, 2014, Samsun	0.053662	0.053662	0.018922	0.018922	0.012443	0.012443	0.016200
2013, Aksaray	0.121977	0.121977	0.065696	0.065696	0.017317	0.017317	0.069511
Düzce	0.103653	0.103653	0.035261	0.023580	0.023580	0.023580	0.010014
2013, Gemlik	0.133993	0.030999	0.030999	0.012976	0.012976	0.002502	0.070394
2013, Yalova	0.131066	0.040385	0.040385	0.040385	0.042653	0.042653	0.009131
2014, Uşak	0.100746	0.100746	0.054793	0.054793	0.054793	0.054793	0.016200
2015, Polatlı	0.259830	0.259830	0.073313	0.073313	0.073313	0.073313	0.067743
2014, İzmir	0.071656	0.071656	0.033220	0.033220	0.020549	0.020549	0.003534
2014, Manisa	0.084557	0.084557	0.023010	0.023010	0.023010	0.023010	0.004713
2014, Niğde-Nevşehir	0.159459	0.159459	0.067282	0.067282	0.067282	0.067282	0.028865
2015, Bilecik-Bolu	0.117051	0.117051	0.030168	0.030168	0.030168	0.030168	0.004713
2015, Karabük-Kastamonu-Çankırı	0.101209	0.101209	0.045665	0.045665	0.045665	0.045665	0.020323
Tekirdağ	0.162833	0.162833	0.037508	0.037508	0.037508	0.037508	0.000000
2015, Yozgat	0.121267	0.121267	0.058457	0.058457	0.058457	0.058457	0.051838
2014, Malatya	0.123265	0.123265	0.080955	0.043847	0.043847	0.043847	0.010898
2015, Kahramanmaraş	0.181269	0.181269	0.068859	0.068859	0.055437	0.055437	0.002651
2015, Denizli	0.070420	0.070420	0.022160	0.022160	0.022160	0.022160	0.000000
2015, Gaziantep-Kilis	0.188166	0.188166	0.076490	0.062123	0.062123	0.062123	0.000000
2015, Şanlıurfa	0.105546	0.105546	0.038501	0.024283	0.024283	0.024283	0.027981
2015, Çanakkale	0.126750	0.126750	0.042728	0.042728	0.042728	0.042728	0.000295
2015, Afyonkarahisar	0.237247	0.237247	0.109516	0.109516	0.109516	0.109516	0.000000
2015, Erzincan	0.153589	0.153589	0.055342	0.055342	0.055342	0.055342	0.026214
2015, Karaman	0.087545	0.087545	0.042717	0.042717	0.042717	0.042717	0.042413
2015, Amasya-Tokat	0.140083	0.140083	0.055530	0.055530	0.055530	0.055530	0.000000
2015, Antalya	0.194815	0.194815	0.194815	0.096690	0.096690	0.012116	0.000000
2015, Karacabey-M.kemalpaşa...	0.219302	0.219302	0.062915	0.062915	0.062915	0.062915	0.023857
AVERAGE	**0.119599**	**0.114757**	**0.050684**	**0.044511**	**0.041276**	**0.037437**	**0.022716**

Despite the fact that distribution companies' license extension period has been linked to service quality, a comprehensive road map for the end of the 30-year licensing period has not been drawn yet. There is an important **regulatory lag** in this area.

To avoid the abuse of the natural monopoly situation, regulations regarding the distribution companies' gas purchases should be carried out sensitively. In this context, it is important to implement a number of additional regulations by taking the definition of "public service" in the legislation and considering the "public service" qualification without removing the dynamic structure of the private sector.

The failure of the distribution companies to fulfill their obligations under the "shipment control center" also negatively affects the wholesale segment. Explanatory regulations for this kind of critical areas should be completed in time.

On the other hand, EMRA is carrying out important works in order to reduce **information asymmetry**. The functioning of the Electronic Information System, the regulatory account plan, and the request of the Certified Public Accountant approval for the financial tables are effective arrangements to reduce the **"information asymmetry".**

Evaluations of the Regulatory Applications in the Turkish Natural Gas Distribution Sector based on the elements mentioned in section three are summarized in Table 4.2.

4.4.2.2 Impacts of Regulatory Applications on the Sectoral Performance of the Turkish Natural Gas Distribution Sector

In addition to the above evaluations, the performance of the Turkish natural gas distribution sector and distribution companies have also been examined.

In this framework, it is seen that the Operating Expenditures (OPEX) of the tendered companies have been increased rapidly after 2011 (Figs. 4.3 and 4.4). It is possible to say that the function of consumers' benefiting from the productivity achieved by the tendered companies during the tender period is rapidly disappearing due to the increase in OPEXs at various ratios. The auctioneers have made significant cuts in OPEXs over the 8-year period in which tariffs are fixed, and the "price cap" method had been influential in real terms. On the other hand, in the years when tariff methodology was adopted, OPEXs has been increased rapidly due to the approach in methodology. In this context, average OPEX of the tender companies is converging to the average OPEX of the existing companies (Fig. 4.3).

In order to ensure a **public-private ownership comparison**, the last tariffs in public ownership have been brought up on a daily basis and compared with the private sector tariffs (Fig. 4.5). It is seen that some of the tender companies, along with the methodology, are carrying out distribution activity at a much higher cost than the public period costs. In the 8-year fixed tariff period, the service had been offered to consumers with a huge price advantage compared to the public period, on the other hand, it has been increased rapidly after the fixed tariff period, and in some regions, it has been exceeded the prices of the public ownership. These kind of excessive increases lead us to think about the regulatory capture, information asymmetry, gold plating, transparency and too big to fail problem.

Table 4.2 Evaluations of the regulatory applications in the Turkish natural gas distribution sector

Elements to measure regulatory effectiveness/regulatory failure	Negative indications	Positive indications
(a) Regulatory impact analysis	RIAs were not observed for the secondary legislation drawn by EMRA. Ex-ante measurement of the regulations were not implemented effectively.	–
(b) Regulatory capture	The fact that a majority of the regulations were against consumers could be interpreted as a problem of "regulatory capture". In the level of creating the "Regulated Asset Base", it is seen that in the tariff methodology, many incentives are taking place in order to provide sustainability of a sector that has taken great "risks" during the tender.	–
(c) Information asymmetry	Ratchet effect was observed in the market after tender period, 8 years fixed term. Information asymmetry is a big concern since the data are generally obtained from distribution companies for the service quality studies.	EMRA has successfully implemented licensing processes. The functioning of the Electronic Information System, the regulatory account plan, and the request of the Certified Public Accountant approval for the financial tables were effective arrangements to reduce the "information asymmetry".
(d) The Averch-Johnson effect/ Gold Plating	The Reasonable Rate of Return which was determined as 11.83% for the period of 2012–2016 and 12.85% for the period of 2017–2021 were high and caused "A-J effect".	–
(e) "Too Big to Fail" problem	Regulatory authority prevented the whole industry from collapse, however this application caused too big to fail problem. Regulations and incentives for ensuring the sustainability of the sector show that the problem of "too big to fail" in the natural gas distribution sector has been occurred.	–
(f) "Free Riders" problem	The free riders problem arisen from subsidies among different consumer groups (in a negative way for big consumers in all distribution regions during the 8 years period, fixed term—see Table 4.1 for detail). This subsidization continues in most of the distribution regions after 8 years of period. An effective study on "vulnarable consumers" in the natural gas sector has not been carried out yet.	Number/amount of unpaid bills were not very high.

(g) Transparency	Consumers’ contributions or evaluations have not been adequately received during the tariff settings and secondary legislation processes. A consumer cannot be able to see the costs spent for him/her. Regulatory agency don’t announce the comparison of the companies publicly. Board meetings were not broadcasting. Opposing votes and reasons against the decisions were not sharing with the public.	Regulations and Procedural Principles prepared by EMRA and the amendments in this scope have been opened for consultation on the web page of the agency for at least 1 month and finalized in line with the opinions received from the market. Meetings and workshops with the sector have also worked on the legislative arrangements.
(h) Regulatory Lag/Regulatory Evasion	It is thought that explanatory regulations for a number of critical areas could not be completed in time. The fact that detailed arrangements for some issues that need to be determined before “distribution tenders” could not be realized have caused major problems. Determination of the distribution prices at the end of the 8 year had not been clarified sufficiently before the auctions. Some of the critical issues had not been clarified before privatization processes of some companies. Despite the fact that distribution companies’ license extension period has been linked to service quality, a comprehensive road map for the end of the 30-year licensing period has not been drawn yet. Regulations regarding the distribution companies’ gas purchases should be carried out sensitively. It is important to implement a number of additional regulations by taking the definition of “public service” in the legislation. These studies have not been carried out yet. The failure of the distribution companies to fulfill their obligations under the “shipment control center” also negatively affects the wholesale segment.	The objective set forth by the political authority for the dissemination of natural gas has been achieved through natural gas distribution tenders. There has been no significant regulatory lag in setting tariffs. EMRA clarified some critical issues before privatization of BAŞKENTGAZ.

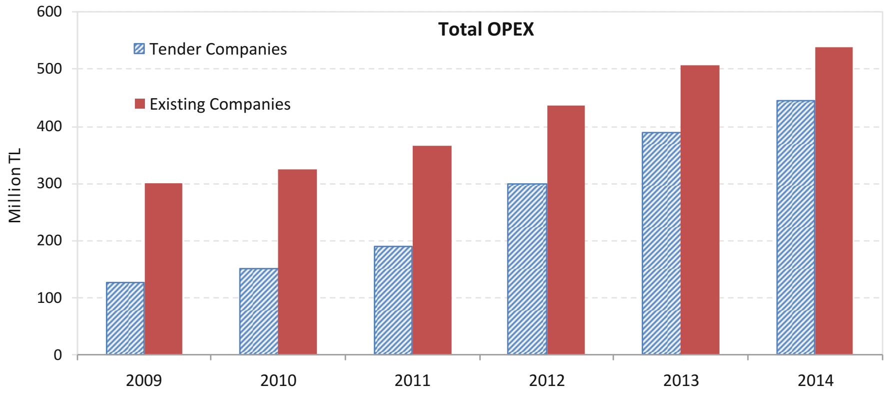

Fig. 4.3 Total OPEX—Comparison of existing companies/tendered companies (data of the figure was derived from EMRA and used by Institution's permission)

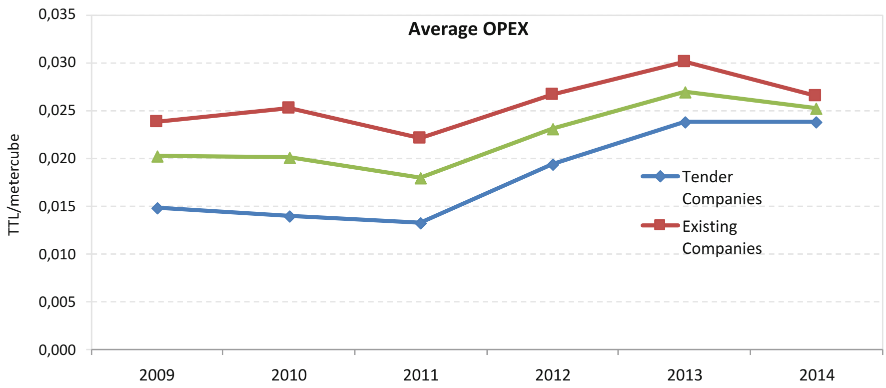

Fig. 4.4 Average OPEX (TL/metercube)—Comparison of existing companies/tendered companies (data of the figure was derived from EMRA and used by Institution's permission)

Although an incentive has been introduced in tariff methodology for **R&D spending**, it is observed that there is a decrease in the ratio of R&D expenditures of distribution companies and the investments are not at the desired level due to the vagueness of implementation (Table 4.3). On the other hand, another reason of decreasing of R&Ds share in operating expenses of the tender companies (Table 4.3a) is the rapid increase in operating expenses. As it was mentioned before, OPEXs were determined by EMRA after 8 years and this caused a sharp decrease in R&D ratios from 2011 to 2012 (Table 4.3a and c).

R&D investments are very important for dynamic efficiency and companies may be able to lose their motivations for innovation and R&D investments in a monopole area. On the other hand, the regulatory authority should evaluate the kind of R&D needs in the distribution sector sensitively in order to prevent waste of resources. RIA is an important necessity to implement effective regulations regarding R&D.

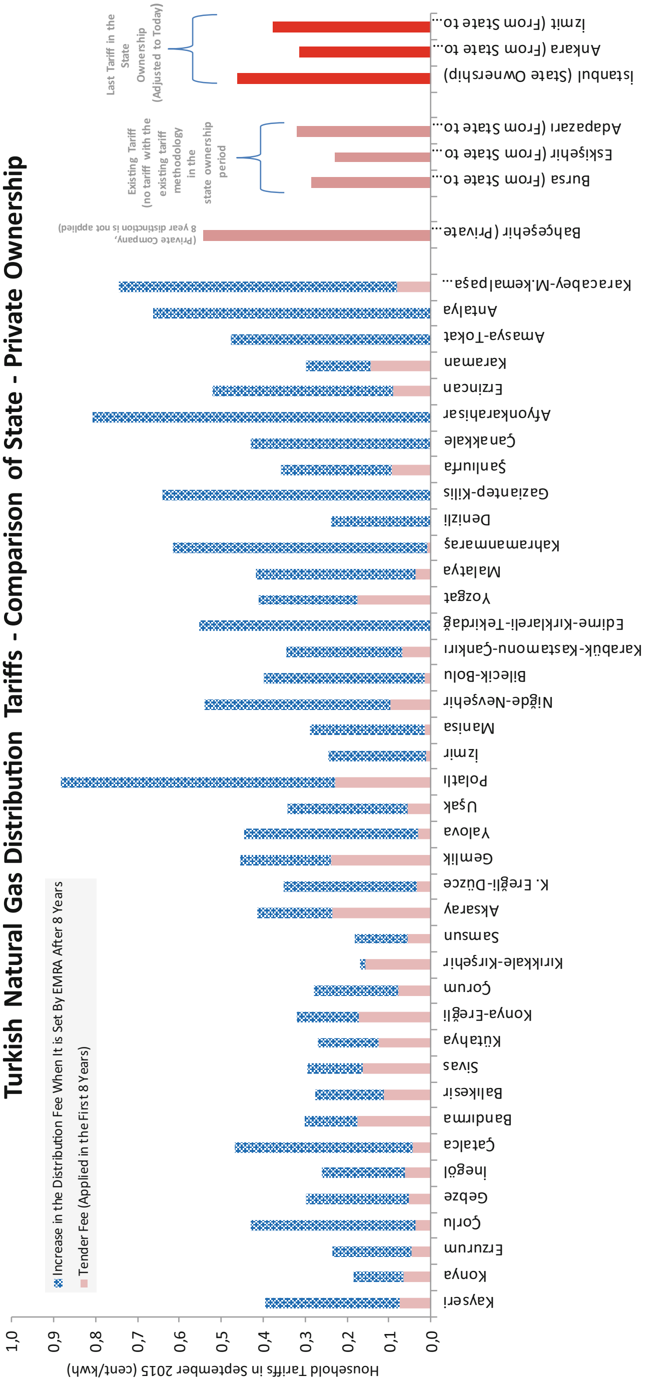

Fig. 4.5 Comparison of state—private ownership (source of data: board decisions-EMRA website)

Table 4.3 R&D expenditures (data of the table was derived from EMRA and used by Institution's permission)

Years	(a) Total of tendered companies		(b) Total of existing companies		(c) Whole sector	
	R&D expenditures (TL)	R&D expenditures/ OPEX	R&D expenditures (TL)	R&D expenditures/ OPEX	R&D expenditures (TL)	R&D expenditures/ OPEX
2009	1,166,834	0.92%	1,074,948	0.36%	2,241,782	0.53%
2010	1,722,085	1.14%	1,160,141	0.36%	2,882,226	0.61%
2011	2,049,575	1.08%	1,323,059	0.36%	3,372,634	0.61%
2012	1,294,085	0.43%	1,206,324	0.28%	2,500,408	0.34%
2013	1,553,303	0.40%	1,728,822	0.34%	3,282,125	0.37%
2014	1,689,724	0.38%	1,902,365	0.35%	3,592,089	0.37%

Finally, an empirical study on "efficiency" and "quality of service" in the natural gas distribution sector of Turkey was carried out. We examined the Yardımcı and Karan's (2015) conclusion that "distribution companies that are providing efficiency in operating expenses have been shortened from service quality." "Efficiency scores" have been calculated by the Data Envelopment Analysis and the Stochastic Frontier Analysis. A significant distinction is observed between the "efficiency scores" and "service quality scores" that obtained from the comparison of the data provided by the companies, at 95% confidence level in 2010 and 2011. In this framework, it is considered that the tariff applications for the quality of service and the introduction of reward/punishment systems are required. It is therefore suggested that the service quality scores may be included as a variable in the efficiency calculations. By this way effectiveness may be important instead of efficiency during the tariff calculations. The regulator's objectives for effectiveness can only be achieved if quality service is provided along with efficiency gains. Careful analysis of this issue is also crucial in testing the success of liberalization or privatization policies. State-owned companies operating before the liberalization period should be evaluated by the technology and conditions of that period not in today's conditions. These kinds of manipulative results lead us to think about the information asymmetry and transparency problem.

As a result, evaluations on sectoral performances, including public-private ownership comparison and R&D expenditures and an empirical study on efficiency and service quality have been supported the results obtained in Sect. 4.4.2.1.

4.5 Summary and Conclusion

The Turkish Natural Gas Market Law, which was enacted under the influence of the structural reforms carried out in Europe, aimed at establishing a liberal gas market in Turkey. It was initially planned to create a competitive market or achieve a competitive environment by a series of regulations for the natural monopoly activities. Turkey restructured its natural gas market in parallel with the aim of the Law and market activities have been separated, state-owned companies have been unbundled and private companies have been involved in the natural gas sector.

In this chapter, the regulatory effectiveness of the Turkish natural gas distribution sector, which has gone from state ownership to private sector ownership was analyzed. The hypothesis *"effectiveness of regulation has been achieved in the Turkish natural gas distribution sector"* was tested. In this context, regulatory practices and performances of distribution companies were examined.

The law aimed to widen the natural gas usage throughout the country. The basic objective set forth by the political authority for the widening of the natural gas usage has been achieved through the regulations in the Turkish natural gas distribution sector. EMRA established secondary legislation for the natural gas distribution sector by several Regulations, Communiqués and Board Decisions. There was not any significant regulatory lag for the tariff settings. On the other hand, consumers' contributions or evaluations have not been adequately received during the regulatory studies. Reasonable Rate of Returns were determined high by the regulatory authority and this caused A-J effect for the investments. Regulations and incentives for ensuring the sustainability of the sector showed that the problem of "too big to fail" in the natural gas distribution sector has been occurred. The fact that a majority of the regulations were against consumers could be interpreted as a problem of "regulatory capture".

As a result of this study, it is seen that consumers are exposed to high costs or low service quality. It is understood that applications for reducing the costs through the development of the sector and especially through investments in R&D have not been carried out effectively. The results obtained in this context are partially considered as regulatory failure.

It may be useful to extend the study by some comparisons with the European countries in the further studies. It is hoped that the results of the work could be useful for the relevant institutions and organizations, as well as to assess regulation success or regulatory failure in the other segments of the Turkish energy market. It is also possible to utilize the results of this work for the studies on "market failure" or "government failure". It is thought that it will be useful to repeat and improve the work at certain time periods.

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Part II

Finance

The Crowding-Out Effect of Green Energy Innovation

5

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Abstract

The U.S. government annually invests $700 million in the research and development of green energy. Yet, the question whether corporate research in green energy leads to increased corporate performance remains unanswered. Based on a sample of 130,000 patents granted by 212 U.S. firms between 1975 and 2006, this chapter tests and compares the impact of green and non-green energy innovation on firms' financial performance and value. While innovation increases firm performance and value, we find that innovation in green energy has a significant and negative impact on future operating performance and reduces firm value. These results suggest that firms crowd out more profitable non-green projects for green innovation, thereby reducing their value and performance. We further find that investors understand this crowding-out effect of green innovation, as the market reacts negatively around and after the granting date of green energy patents.

Keywords

Green energy · R&D · Patents · Crowding out · Firm value

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5.1 Introduction

Thanks to societal and political efforts over the last decade, green energy research gained increasing interest and funding from both governments and corporate entities (REN21 2016). Global efforts, such as the 2002 Kyoto Protocol and the 2016 Paris Agreement, came forth out of growing concerns over current sustainability and energy practices, and allowed countries to publicly demonstrate their commitment to invest in green energy innovation. Yet, the central importance of green energy innovation is in sharp contrast with the limited evidence concerning its impact on firms' value and financial performance. This chapter aims to fill this gap and contributes in providing new evidence on the unresolved question of how investment in green energy innovation impacts firm performance and value. Understanding this relationship will help managers, shareholders, and policy makers to answer the widely debated question of whether firms gain economic opportunities by investing in green energy innovation.

Managers are required to adopt dynamic and innovative business models to remain competitive. Innovation not only drives future firm performance, but also leads to general economic growth (Romer 1986). The link between innovation and firm performance has been investigated in a large number of studies (see, e.g., Jaffe and Palmer 1997; Johnstone et al. 2010; Popp 2002; Verdolini and Galeotti 2011), with the general conclusion that innovation increases future economic performance. Despite the evidence, there is a long-running debate on whether managers should introduce green energy innovation into their strategic decisions. On the one hand, Wörter et al. (2015) argue that green innovation is crowding out more profitable, non-environmentally friendly projects, requiring firms to increase operating costs and give up shareholder wealth. On the other hand, some studies find that such initiatives can lead to new market opportunities, and be cost-saving, rather than cost-inquiring (Marin 2014; Marin and Lotti 2017). For example, Hart and Ahuja (1996) and King and Lenox (2000) argue that proactive pollution prevention techniques embedded in the firm's production processes are more likely to increase operating efficiency and profitability, all of which could ultimately be perceived positively by capital markets. Also, the findings of Ganda (2017) confirm that, after controlling for corporate risk, growth and cash flow, green R&D investment has a positive relationship with corporate market value of 14 South African mining firms which are listed on the Johannesburg Stock Exchange SRI index. Overall, the evidence focusing on green energy innovation can be described as ambiguous.

Using a comprehensive NBER's patents database composed and made available by Hall et al. (2001), we examine the impact of green energy innovation between 1975 and 2006. We first investigate how a firm's innovative behavior influences financial value and performance. In line with the prior literature, we find evidence suggesting that innovation is significantly and positively associated with future firm performance and increases firm value. On the other hand, we show that a stronger focus on green energy innovation negatively affects future corporate performance and future firm value. We next test the critical question whether investors react to green energy innovation. This question is examined by studying how investors react to green energy innovation around the patent granting date. We find that, while innovation has a positive impact on abnormal stock returns around the patent granting date, the marginal price effect of innovation decreases for green energy technology. Furthermore, this negative impact is not limited to a small window of days around the patent release date, but continues long after the event date. In fact, we find evidence of a longer negative impact of green energy innovation on the returns, in a 60-day and 180-day window. We interpret this result as evidence that investors can see through the wealth-reducing dynamics behind green innovation and interpret a firm's green innovative efforts as a negative signal concerning the future performance of the firm.

Overall, this chapter contributes to the debate on corporate environmental innovation practices by showing that firms that invest in green energy innovation forgo more profitable non-green projects for green innovation, thereby reducing firms' future performance. We further contribute by showing that the market understands this crowding-out effect and reacts negatively towards patents around and long after their granting date.

The remainder of this chapter is organized as follows. Section 5.2 starts with a literature review on contemporaneous development in green energy, and reviews the impact of innovation on firm performance, and constructs the hypotheses. Section 5.3 describes the data, the models and variables. Section 5.4 provides the results and Sect. 5.5 concludes.

5.2 Literature Review and Hypothesis Development

The conflict between economic growth, innovation and environmental welfare has been a prominent point of discussion over the last decades. Maintaining and even increasing social wealth creates an important challenge given the rising population and globalization. According to the Organization for Economic Cooperation and Development (OECD), Earth's population is expected to rise over 9 billion by 2050 in a world economy that will more than triple in size (OECD 2012). Considering these numbers, it is projected that energy consumption will increase by 80%, of which the OECD expects fossil-fuel to provide a lion's share of 85% of total consumption. Following these estimations, the expected emitted green-house gasses will increase the planet's temperature well over the globally agreed-upon limit of 2 °C. Therefore, a drastic shift towards green technology is necessary in order to counter global warming and provide a sustainable world.

This, in turn, stresses the need for governments and institutions to stimulate green investments. A recent report by REN21[1] finds that 2015 was a record year for investments in renewable energy, with a total of $285.9 billion globally, reporting a 5% growth compared to that in 2014 (REN21 2016). It is interesting to note that

[1]The Renewable Energy Policy Network for the twenty-first Century.

developing countries invest more in green energy than developed countries because of their increase in electricity demand on the one hand, and due to a large reduction of investments by Europe on the other. The U.S. and China remain the largest investors, with $44.1 and $102.9 billion, respectively.

The amount of corporate investment in R&D also supports the more general notion that innovation constitutes an essential part of any firm's survival strategy. Due to the globalization of the world economy, the ability to create a continuous wave of innovation is essential for the profitability and existence of most firms (see, e.g., Romer 1986, 1990; Wang 2011). Using R&D investment as a proxy for innovation, prior research has investigated the relationship between innovation and future firm performance, with the general conclusion that a higher level of R&D investment and R&D growth are positively associated with future returns (Chan et al. 2001; Eberhart et al. 2004). In fact, innovation allows firms to respond to consumer preferences, change their products and alter their production processes. Some technological advances even lead to the development of new industries and firms. For example, Rao (1999) shows how the rise of the internet reshaped the firm-consumer relationships in various fields such as retail, music, and banking.

Yet, increased returns come at the cost of increased risk. Innovation can be costly and take a long time, without any guarantee of success. In line with traditional financial theory (Markowitz 1952), the literature finds that innovation intensity increases firm risk (see e.g., Chan et al. 2001; Lev et al. 2006). Mazzucato and Tancioni (2012), for instance, investigate the relationship between volatility and innovation using firm level patent data. They argue that firms which invest in innovation (more R&D and more patents) experience more volatility in their returns. Their results suggest a positive and significant relationship between volatility, R&D intensity and the various patent related measures, especially when innovation measures are filtered to distinguish the very innovative firms from the less innovate ones. Similarly, Kothari et al. (2002) report that future earnings volatility is positively affected by the degree of R&D investments. Shi (2003) and Eberhart et al. (2007) further confirm that R&D investment leads to an increase in firm risk.

5.2.1 Impact of Green Energy Innovation on Firm Performance

In the following section, we develop the hypotheses of the impact of green innovation on firm performance. We distinguish two sides in the literature. First, green innovation is shown to crowd out more profitable non-green projects, leading to a negative effect on future performance (*Crowding-out Hypothesis*). Second, the *Porter Hypothesis* suggests a positive relationship between green innovation and performance, through enforced regulation.

5.2.1.1 Crowding-Out Hypothesis: A Negative Impact of Green Energy Innovation

The 'so-called' Lauderdale paradox is introduced by James Maitland, Earl of Lauderdale, one of the most prominent nineteenth century classical economists.

This theory distinguishes between 'public wealth' and 'private riches' and argues that there exists a mutual exclusivity between the two (Daly 1998). According to this paradox, an increase in private wealth (firm performance and shareholder value) is always accompanied by a decrease in public wealth (environment). Following this reasoning green energy innovations, which by default benefit 'public wealth', are crowding-out more profitable non-green projects, which solely increase 'private wealth'. If firms function as wealth-maximizing entities, their R&D projects are chosen such that they maximize private returns, consequently, shareholder wealth. Therefore, by engaging in green innovations, these firms directly oppose their function as wealth-maximizers because they reduce the profitability and outcome for shareholders.

There exists empirical evidence pointing towards the existence of such a crowding-out effect. Perman and Stern (2003), Marin (2014) and Marin and Lotti (2017) argue that the profits of green energy projects might not be directly allocated to the firm, but might increase social wealth, such that the returns are lower than their non-green counterpart. Lanoie et al. (2011) study green R&D, driven by environmental regulations, and report a positive effect of environmental R&D on profitability. However, they also find that this positive effect can be offset by the cost of compliance (e.g. by high investments in alterations for the business processes). More recently, Wörter et al. (2015) show a negative association between green innovation and productivity at the industry- and firm-level. Popp and Newell (2012) and Noci and Verganti (1999) state that green innovations are relatively new, such that they require more costs due to the organizational restructuring and development of business processes. We therefore formulate the following hypothesis:

H1A *Innovation in green energy negatively affects future firm value and performance.*

5.2.1.2 Porter's Hypothesis: A Positive Impact of Green Energy Innovation

While the crowding-out hypothesis argues that green innovation reduces firm performance, numerous arguments point towards a potential positive relationship. In fact, according to Porter and van der Linde (1995), strict environmental regulations can force firms to engage in green innovation, thereby improving their competitiveness. For example, Colombelli et al. (2015) report that the increase of environmental policies and regulations raises the demand for green products, such that higher returns may arise through simple supply-and-demand mechanics. As such, green innovations may become general purpose technologies and can incur high revenue in the long run (Helpman 1998).

Moreover, reducing energy consumption and pollutants may have a cost-saving aspect through production costs and waste. Using a sample of patents by German firms, Rave et al. (2011) find that the benefits of an environmental regulatory framework lead to potential cost savings, and the possibility of new market development. Popp and Newell (2012) further argue that green innovation is relatively new and present a field of opportunity for firms to engage in, which may lead to higher private returns in the long run. Moreover, using a large set of Italian firms, Marin (2014) reports that firm performance is not significantly affected by green energy innovation, whereas their non-green counterpart have a significantly positive effect. Extending this research by using a larger panel data set, Marin and Lotti (2017) find evidence of a positive association between green innovations and future productivity, but to a lesser extent than non-green innovations do. More convincing evidence comes from Ayari et al. (2012), who report a positive impact of renewable energy patents on the future performance of firms in an extensive European dataset. Given the theoretical foundation and empirical studies on the *Porter Hypothesis*, we similarly argue that:

H1B *Innovation in green energy positively affects future firm value and performance.*

5.2.2 Investors' Reaction to Green Innovation

Given the potential impact of green innovation on firm performance, the question is whether investors are able to assess the value of green energy innovation and react to patent granting. Hall et al. (2005) find a significant positive association between forward citations of patents and the firm's market value. They conclude that investors behave forward-looking in terms of innovation and understand its value. Erturk et al. (2004) show that positive announcements, such as patent filings, are positively associated with the stock price. Dornelles and Ali (2014), further find that innovation, measured by forward citations, is positively associated with the cumulative abnormal returns.

If green energy innovation is negatively associated with future performance, green technology should minimize shareholder revenue, such that we can expect investors to negatively react around and after patent granting dates:

H2A *Investors negatively react to the announcement of green energy innovation around and after green energy patent granting dates.*

On the other hand, if green innovation positively affects future performance, investors should positively value a firm's green innovation and positively react around and after green energy patent granting dates:

H2B *Investors positively react to the announcement of green energy innovation around and after green energy patent granting dates.*

5.3 Data, Variables and Model

In this section, we discuss why and how we use patents as a proxy for innovation, present the construction of our dataset and provide more details on the models used to test our hypotheses. A list of all relevant variables can be found in Table 5.1.

5.3.1 Proxies for Innovation

Innovation is frequently measured by using firm-level R&D expenditures. Yet, R&D expenditures are generally proxied by using accounting data and are thus often inaccurate due to the lack of accounting regulation and standards concerning R&D reporting (Loosemore 2014). A large stream of research therefore proxies innovation through intellectual property, measured by patents. According to Nordhaus (1969), the patent system stimulates innovation by giving the firm the sole power to use an invention and thus recover the cost of its initial investment (Koller et al. 2004). In return, the firm makes the technical documents behind its inventions available to the public. In doing so, they provide an additional stimulus to rival firms to improve and invest in research to create inventions which bypass the existing patent, resulting in economic growth (Romer 1986).

The literature on measuring innovation through patents starts with Scherer (1965) who uses the number of issued patents as an indicator of innovativeness at the firm-level. Schmookler (1966) complements this work by studying patent counts at the industry-level. Notwithstanding their contributions, measuring patent value is an issue that economists have been trying to tackle to date. The main issue is that the technological impact, as well as the economic value, can strongly differ from patent to patent (Mitsuyama 2013). While some patents are nearly impossible for competitors to reproduce, they might still not have the expected market impact, and incur a cost rather than a competitive advantage. As such, using a simple patent count might not provide a thorough economic interpretation of their value. Pakes and Schankerman (1986) therefore opt to use renewal fees. The owner of a patent has to pay an annual fee to maintain control over, and the exclusive right to use the invention. However, renewals might proxy more for the strengths of the underlying legal patent protection system, since a firm would not file for renewal if the patent was not sufficiently protected (see e.g. Griliches et al. 1991). Therefore, Pakes (1986) and Lanjouw (1989) use the patent return to drop-out rates to proxy for patent value, since it intuitively measures its underlying worth better.

More recent work proxies patent value by their “forward citations”, referring to the number of citations made by future patents to the current patent (see e.g. Bapuki et al. 2011; Chen and Chang 2010; Deng 2008; Haroff et al. 2003). Every patent is required to cite previous patents (also referred to as “prior art”) that provide the basic insights leading to the development of the current application. Examiners of patents even add other relevant patent citations to the existing applicator’s patent, such that the prior art conveys all useful prior inventions in an unbiased way (Falk and Train 2016). The number of citations is a measure of the innovation’s impact, and thus

Table 5.1 Variable definitions

Variable	Variable description
Panel A—Dependent variables	
ROA^{Y+n}	The *ROA* for firm *i* in the *n*th year with respect to quarter *q* of year *t*. More formally, we study the behavior over three consecutive years after the granting of the patent: ROA^{Y+1}, ROA^{Y+2}, ROA^{Y+3}. (Compustat)
$TobQ^{Y+n}$	The Tobin's Q for firm *i* in the nth year, with respect to quarter *q* of year *t*. Tobin's Q is calculated as: (closing price of the quarter) · (common shares outstanding)/(total assets). More formally, we study the behavior over three consecutive years after the granting of the patent: $TobQ^{Y+1}$, $TobQ^{Y+2}$, $TobQ^{Y+3}$. (Compustat)
$ACAR[a; b]$	The average of the cumulative abnormal returns for firm *i* within a [*a;b*] window around the patent granting dates of quarter *q* in year *t*. The cumulative abnormal returns are acquired using a market model that is estimated over a window of [d-315; d-63] prior to each patent's granting date. More specifically, we use the following estimation windows: $ACAR[-1; +1]$, $ACAR[+2; +62]$, $ACAR[-5; +180]$. (CRSP)
Panel B—Control variables	
PatentValue	The logarithm of the average number of forward citations across all *n* patents firm *i* received in quarter *q* of year *t*: $PatentValue = \log\left(\frac{\sum_{p=1}^{n} ForwardCitations}{n}\right)$, where *ForwardCitations* represents the number of citations patent p granted to firm *i* received in quarter *q* of year *t*, and *n* the number of patents received in that quarter. (NBER)
GreenPatents	The average number of green patents firm *q* was granted in quarter *q* of year *t*: $GreenPatents = \frac{\sum_{p=1}^{n} DummyGreen}{n}$, where *DummyGreen* is a dummy-variable taking on the value of '1' if patent *p* granted to firm *i*, qualifies as a green patent as defined by "IPC Green Inventory" database. *n* represents the number of patents received in that quarter. (NBER)
BookToMarket	Book-To-Market ratio for firm *i* in quarter *q* of year *t*. (Compustat)
MarketCap	Logarithm of the market capitalization of firm *i* on the last day of the quarter *q* of year *t* (in mil.), i.e. P · *CSHO*, where *P* represent the price of firm *i* on the last day, *d*, of quarter *q* of year *t* and *CSHO* captures the number of common shares outstanding of firm *i* at the end of quarter *q* of year *t*. (Compustat)
TotalLiabilities	The total liabilities of firm *i* (in mil.) in quarter *q* of year *t*. (Compustat)
ROA	ROA before extraordinary items/total assets, of firm *i* in quarter *q* of year *t*. (Compustat)
σ_{ROA}	Standard deviation of ROA over the last 5 years. (Compustat)
Alpha	Quarterly average of the intercepts, $\widehat{\alpha}$, of the market models, estimated over the [d − 315; d − 63] time window, for each patent *p* of quarter *q* of year *t,* and where *d* represents the patent granting date (CRSP): $Alpha = \log\left(\frac{\sum_{p=1}^{n}\widehat{\alpha}}{n}\right)$.
Beta	Quarterly average of the estimated slopes, $\widehat{\beta}$, of all of firm *i*'s patents *p* in quarter *q* of year *t*, based on the market model that spans the [d − 315; d − 63] time window, where d = 0 is the patent granting day of the patent *p,*

(continued)

Table 5.1 (continued)

Variable	Variable description
	i.e. $\beta = cov\,(R; R_M) = var\,(R_M)$, where R_M represents the S&P500 returns on day d of quarter q of year t and R represents firm i's returns on day d of quarter q of year t (CRSP): $Beta = \log\left(\frac{\sum_{p=1}^{n}\widehat{\beta}}{n}\right)$.

indirectly reflects its technological value, and it is found to be positively correlated with economic value and the value of innovation (see e.g. Bloom and Van Reenen 2002; Carpenter et al. 1981; Haroff et al. 2003; Kogan et al. 2012; Nagoaka et al. 2010; Trajtenberg 1990). Hall et al. (2005) find that the more valuable firm-level patents are, the higher the market value of the firm, and Lanjouw and Schankerman (2004) show that patent quality is positively related to stock market value. In line with this research, we use the number of forward citations to proxy for innovation.

5.3.2 Data Collection and Patent Information

The patent citation data is obtained from the NBER Patent Dataset, which is composed by Hall et al. (2001). This data is available on their website and covers the period from 1975 to 2006.[2] Although the dataset does not include more recent time points, we believe the data is valuable and representative of the current phenomenon. Our time data is consistent with contemporaneous research (see, e.g., Ayari et al. 2012; Marin and Lotti 2017; Wörter et al. 2015), in that more recent years cannot be included because a sufficiently long time period must have passed to gather enough citations to correctly proxy for firm value, and to increase the reliability of the data.

To identify which patents are green, we rely on the International Patent Classification (IPC) code assigned to each patent. This IPC is a hierarchical patent classification system providing a category and subcategory to which the invention belongs. In 2010, the World Intellectual Property Organization (WIPO) published a list of environmentally sound technologies based on these IPC codes (WIPO 2017). Therein WIPO follows the definition of the United Nations to define environmentally sound technologies: "... *techniques and technologies capable of reducing environmental damage through processes and materials that generate fewer potentially damaging substances, recover such substances from emissions prior to discharge, or utilize and recycle production residues*" (UN 1997).

[2]The link to their website is https://sites.google.com/site/patentdataproject/. This website not only contains citations data, but also firm identifying information for matching purposes with other databases.

Using the NBER patent data poses some econometric issues in the context of this research. First and foremost, only about 10,000 green patents are available over the sample of over a million patents, which may result in a potential sampling bias. Therefore, we reduce the dataset only to contain firms that were granted at least one green patent over the period of 1975–2006. After merging with relevant control variables from the Compustat, IBES, and CRSP universe, we obtain a sample of 212 firms having granted 131,798 patents of which 2168 patents are green. Secondly, both performance and several control variables are only available on a quarterly basis. Since firms are granted multiple patents per quarter, on various dates, using a simple OLS regression could lead to severely biased results. To counter this issue, we transform our patent data to a quarterly frequency by studying the average number of citations of all the granted patents, $p = 1 \ldots n$, of firm i have received throughout the quarter:

$$PatentValue = \log\left(\frac{\sum_{p=1}^{n} ForwardCitations}{n}\right). \tag{5.1}$$

It must be noted that we take the logarithm of the patent value, since forward citations tend to be strongly skewed. This practice is consistent with prior literature (see, e.g., Tietze 2012). *PatentValue* represents the quarterly value of the granted patents, or patent portfolio, measured by the average number of forward citations. Similarly, we construct the variable *GreenPatents* as the fraction of quarterly green energy patents:

$$GreenPatents = \frac{\sum_{p=1}^{n} DummyGreen}{n}, \tag{5.2}$$

where *DummyGreen* equals '1' if patent p is green and '0' otherwise. By transforming the data to a quarterly frequency, we end up with 10,695 distinct observations, from 212 firms.

5.3.3 Future Performance and Investors' Reaction

Our first hypothesis tests whether green innovations affect future performance. We proxy firm performance using by two variables; return on assets (*ROA*) and firm value (or Tobin's Q, which is denoted as *TobQ*). Since innovation generally take some years to be fully developed, we study the quarterly future operational performance 1-year (ROA^{Y+1}), 2-year (ROA^{Y+2}) and 3-year (ROA^{Y+3}) ahead and do this similarly for Tobin's Q, ($TobQ^{Y+1}$, $TobQ^{Y+2}$, $TobQ^{Y+3}$).[3]

To measure investors' reaction around, and after the patent granting date, we estimate the cumulative abnormal returns, which is denoted as *CAR*. To compute this

[3]Note that we take the logarithm of *TobQ*, and this is consistent with prior research studying patents and firm performance (see, e.g., Czarnitzki et al. 2011).

measure, we take the difference between the observed value of the returns and the expected value, computed by a market model that regresses the firm returns on the market returns in an estimation window starting 315 days before the patent was granted and ending 62 before. *CAR* is then computed as the deviation from the expected returns in a window, [a; b], around the patent granting date *p*:

$$CAR[a;b] = \sum_{j=a}^{b} \left(R_{d+j} - \hat{\alpha} - \hat{\beta} \cdot R_{M_{d+j}}\right), \tag{5.3}$$

where $\widehat{\alpha}$ and $\widehat{\beta}$ represent the firm-specific intercept and slope, obtained by the market model. R represents the daily stock returns form firm i and R_M represents the market returns. It must be noted that we compute the *CAR* for each patent separately in several estimating windows, $CAR[-1;+1]$, $CAR[+2;\ +62]$, and $CAR[-5;+180]$.[4] Also, we take the quarterly average of the *CAR* (henceforth, *ACAR*) since our patent data is unevenly released during each quarter:

$$ACAR[a;b] = \frac{\sum_{p=1}^{n} ACAR[a;b]}{n}. \tag{5.4}$$

5.3.4 Models

We further extend the dataset with a set of relevant control variables to construct the final model. For Hypothesis 1, we add *BookToMarket* to control the firm's growth-level, *MarketCap* to control firm size and *TotalLiabilities* represent the firm's outstanding long-term debt. We additionally control current performance (*ROA* & *TobQ*) and performance volatility (σ_{ROA}). To further control for performance, we include the estimated firm-specific $\widehat{\alpha}$ (*Alpha*) and $\widehat{\beta}$ (*Beta*) from the market model, as used in Eq. (5.3). Alpha controls for the firm's profitability and Beta for the firm's risk. The models are formulated as the following[5]

$$\begin{aligned} ROA^{Y+n} = {} & \beta_0 + \gamma \cdot PatentValue \cdot GreenPatents + \delta \cdot PatentValue \\ & + \vartheta \cdot GreenPatents + \beta_1 \cdot BookToMarket + \beta_2 \cdot MarketCap \\ & + \beta_3 \cdot TotalLiabilities + \beta_4 \cdot ROA \cdot Alpha + \beta_7 \cdot Beta + \varepsilon, \end{aligned} \tag{5.5}$$

and,

[4]Although there exists no consensus on the length of estimation windows for cumulative abnormal returns, the results are generally considered more reliable in smaller windows. Estimation windows of over 200 days are still common within financial literature. More specifically, Eberhart et al. (1999) use a various range of post-event windows for the cumulative abnormal returns, ranging up to 200 days, when studying the behavior of firm's emerging from bankruptcy.

[5]Note that in all our models we add industry, quarter, and year fixed effects, which are not shown in the equations and reported in the results for brevity.

$$\log\left(TobQ^{Y+n}\right) = \beta_0 + \gamma \cdot PatentValue \cdot GreenPatents + \delta \cdot PatentValue + \vartheta \cdot GreenPatents + \beta_1 \cdot BookToMarket + \beta_2 \cdot MarketCap + \beta_3 \cdot TotalLiabilities + \beta_4 \cdot \log(TobQ) + \beta_5 \cdot \sigma_{ROA} + \beta_6 \cdot Alpha + \beta_7 \cdot Beta + \varepsilon. \tag{5.6}$$

Consistent with prior research, we expect to find a positive association between *PatentValue* and future performance. However, following Hypothesis 1A (1B), we expect *PatentValue* · *GreenPatents* in Eqs. (5.5) and (5.6) to be significant and positive (negative).

The last hypothesis tests investors' reaction to green patents. To do so, we construct a model that controls for firm growth level, *BookToMarket*, firm size, *MarketCap*, and current performance *ROA*:

$$ACAR[a;b] = \beta_0 + \gamma \cdot PatentValue \cdot GreenPatents + \delta \cdot PatentValue + \vartheta \cdot GreenPatents + \beta_1 \cdot BookToMarket + \beta_2 \cdot MarketCap + \beta_3 \cdot ROA + \varepsilon. \tag{5.7}$$

We expect a significant association between *PatentValue* · *GreenPatents* and *ACAR* in several time windows around, and after, the patent granting date.

5.4 Results

This section first presents descriptive statistics of the variables and correlation table. We follow with a discussion of our main conclusions.

5.4.1 Descriptive Statistics

Table 5.2 shows the descriptive statistics of the patent information and the relevant dependent and control variables. Our measures of future performance (return on assets and Tobin's Q) do not strongly differ in their distribution. The average quarterly cumulative abnormal returns in various time windows, which proxy for the investors' reaction, have a positive mean in the longer time windows, whereas in a short-term window we find a negative average reaction. The quarterly average of forward citations a patent receives is about 11, with a maximum of 79 and a minimum of 1. This corresponds to prior studies stating that the citations data is rather skewed, indicating a low number of 'valuable' patents (see, e.g., Hall et al. 2001). Moreover, we find that the average proportion of green innovation quarterly granted to firms is about 3%.

Table 5.3 shows that the correlation amongst the operational performance measures ranges between 52% and 72%. Among the different measures of Tobin's Q, this percentage lies between 80% and 90%. Furthermore, there is a significant and positive correlation between *PatentValue* and several measures of

Table 5.2 Summary Statistics

	Mean	Std. Dev.	Min	Median	Max
ROA^{Y+1}	0.013	0.024	−0.088	0.016	0.065
ROA^{Y+2}	0.013	0.024	−0.088	0.016	0.065
ROA^{Y+3}	0.013	0.024	−0.088	0.016	0.065
$TobQ^{Y+1}$	1.3780	1.186	0.101	0.965	5.035
$TobQ^{Y+2}$	1.3780	1.186	0.101	0.965	5.035
$TobQ^{Y+3}$	1.3780	1.186	0.101	0.965	5.035
$ACAR[-1;+1]$	−0.001	0.028	−0.164	−0.001	0.131
$ACAR[+2;+62]$	0.002	0.148	−0.655	0.001	0.537
$ACAR[-5;+180]$	0.001	0.288	−1.171	0.0001	1.114
PatentValue	11.284	9.905	1	9	79
GreenPatents	0.030	0.130	0	0	1
BookToMarket	0.511	0.322	0.056	0.443	1.525
MarketCap (in mil.)	154.385	337.511	3.141	39.610	2993.180
TotalLiabilities (in mil.)	59.682	87.799	0.632	21.366	337.828
ROA	0.013	0.025	−0.093	0.016	0.065
σ_{ROA}	0.004	0.005	0.0003	0.002	0.021
Alpha	0.0002	0.016	−1.352	0.0002	0.439
Beta	1.024	1.419	−14.804	0.957	16.225

This table provides the descriptive statistics of the variables defined in Table 5.1. We note that in the model construction we use transformed (logarithmized) variables for *PatentValue* and *TobQ*, but report the untransformed summary statistics for interpretation purposes

future operational performance. We also find a negative and significant association between *GreenPatents* and the several performance measures, indicating diminished returns in case of environmentally friendly patents. There is only a slightly significant correlation between the several *ACAR*-measures and *PatentValue*, as well as *GreenPatents*. Overall, we find that our variables are sufficiently correlated with each other, such that multivariate regressions are an appropriate tool for the analysis of our hypotheses.

5.4.2 Green Innovations and Future Firm Performance

Table 5.4 provides the results of the impact of general and green energy innovation on future corporate performance. The results are consistent with prior literature and show a significantly positive relationship between *PatentValue* and our various measures of future operational performance. This result suggests that innovation improves a firm's future performance. We further find an increase in statistical significance and in the size of the slope coefficient with the increasing time lag, which reflects the delayed impact of valuable patents on performance. However, we find that the coefficient accompanying our interaction variable *PatentValue* · *GreenPatents* is significantly negative for all our measures of future performance ROA^{Y+1}, ROA^{Y+2}, and *ROA*

Table 5.3 Correlation table

	ROA^{Y+1}	ROA^{Y+2}	ROA^{Y+3}	$TobQ^{Y+1}$	$TobQ^{Y+2}$	$TobQ^{Y+3}$	$ACAR[-1;+1]$	$ACAR[+2;+62]$	$ACAR[-5;+180]$
ROA^{Y+1}	**1.000**	0.655***	0.699***	0.367***	0.313***	0.274***	0.051***	0.029***	0.039***
ROA^{Y+2}	0.565***	**1.000**	0.540***	0.335***	0.292***	0.273***	0.031***	0.028***	0.034***
ROA^{Y+3}	0.600***	0.500***	**1.000**	0.395***	0.329***	0.285***	0.049***	0.009	−0.015
$TobQ^{Y+1}$	0.112***	0.093***	0.126***	**1.000**	0.891***	0.820***	−0.001	0.012	0.004
$TobQ^{Y+2}$	0.062***	0.065***	0.061***	0.867***	**1.000**	0.896***	−0.004	0.01	0.009
$TobQ^{Y+3}$	0.058***	0.067***	0.046***	0.775***	0.866***	**1.000**	−0.01	0.005	0.009
$ACAR[-1;+1]$	0.078***	0.056***	0.063***	−0.027***	−0.027***	−0.027***	**1.000**	0.165***	0.108***
$ACAR[+2;+62]$	0.048***	0.020**	0.019*	0.007	0.016	0.022**	0.169***	**1.000**	0.648***
$ACAR[-5;+180]$	0.054***	0.022**	−0.013	−0.005	0.015	0.031***	0.110***	0.678***	**1.000**
PatentValue	0.085***	0.069***	0.089***	0.016	−0.015	−0.042***	0.018*	0.008	0.002
GreenPatents	−0.034***	−0.020**	−0.032***	−0.029***	−0.033***	−0.042***	0.002	0.001	−0.007
BookToMarket	−0.196***	−0.152***	−0.216***	−0.559***	−0.493***	−0.444***	−0.020*	0.107***	0.193***
MarketCap	0.119***	0.099***	0.145***	0.333***	0.304***	0.267***	0.020*	−0.035***	−0.072***
TotalLiabilities	−0.033***	−0.031***	−0.034***	−0.137***	−0.127***	−0.127***	0.029***	0.003	−0.002
ROA	0.555***	0.483***	0.617***	0.173***	0.083***	0.046***	0.048***	−0.055***	−0.145***
σ_{ROA}	−0.354***	−0.257***	−0.373***	0.205***	0.214***	0.214***	−0.058***	0.001	0.007
Alpha	0.059***	0.006	0.120***	0.01	0.005	0.023**	−0.156***	−0.439***	−0.600***
Beta	−0.072***	−0.042***	−0.088***	0.267***	0.244***	0.227***	−0.067***	−0.024**	−0.039***

	PatentValue	*GreenPatents*	*BookToMarket*	*MarketCap*	*TotalLiabilities*	*ROA*	σ_{ROA}	*Alpha*	*Beta*
ROA^{Y+1}	0.109***	−0.050***	−0.349***	0.170***	−0.092***	0.650***	−0.239***	0.139***	0.007
ROA^{Y+2}	0.081***	−0.045***	−0.295***	0.143***	−0.084***	0.520***	−0.172***	0.086***	0.019*
ROA^{Y+3}	0.127***	−0.054***	−0.376***	0.187***	−0.100***	0.704***	−0.238***	0.186***	0.004
$TobQ^{Y+1}$	0.030***	−0.062***	−0.682***	0.259***	−0.232***	0.446***	0.117***	−0.023**	0.204***
$TobQ^{Y+2}$	0.002	−0.066***	−0.611***	0.234***	−0.224***	0.357***	0.140***	−0.009	0.174***
$TobQ^{Y+3}$	−0.035***	−0.076***	−0.551***	0.207***	−0.223***	0.306***	0.146***	0.006	0.177***
$ACAR[-1;+1]$	0.023**	0.007	−0.029***	0.049***	0.046***	0.027**	−0.037***	−0.124***	−0.049***
$ACAR[+2;+62]$	0.008	0.001	0.094***	−0.039***	0.003	−0.043***	0.014	−0.402***	−0.018*
$ACAR[-5;+180]$	0.004	−0.001	0.178***	−0.083***	−0.003	−0.108***	0.004	−0.564***	−0.042***
PatentValue	**1.000**	−0.019*	0.053***	−0.042***	−0.086***	0.143***	−0.026**	−0.008	0.107***
GreenPatents	−0.055***	**1.000**	−0.011	0.187***	0.218***	−0.061***	−0.038***	−0.014	−0.003
BookToMarket	−0.011	0.021**	**1.000**	−0.431***	−0.054***	−0.382***	−0.048***	−0.254***	−0.104***
MarketCap	−0.088***	0.027***	−0.305***	**1.000**	0.808***	0.202***	−0.097***	0.045***	0.080***
TotalLiabilities	−0.113***	0.073***	−0.026**	0.571***	**1.000**	−0.104***	−0.142***	−0.091***	−0.074***
ROA	0.096***	−0.025**	−0.209***	0.162***	−0.040***	**1.000**	−0.206***	0.181***	0.017
σ_{ROA}	0.025**	−0.009	−0.067***	−0.028***	−0.093***	−0.344***	**1.000**	−0.032***	0.139***
Alpha	0.015	−0.009	−0.245***	0.033***	−0.061***	0.149***	0.041***	**1.000**	0.013
Beta	0.090***	−0.029***	−0.101***	0.000	−0.100***	−0.073***	0.213***	0.036***	**1.000**

This table reports the Pearson (lower triangle) and Spearman (upper triangle) correlation for the different tone measures and control variables. *, ** and *** denote significance level at the 10%, 5% and 1% level, respectively

Table 5.4 Future operational performance and green energy innovation

	ROA^{Y+1}		ROA^{Y+2}		ROA^{Y+3}	
Future performance	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
(Intercept)	**0.023*****	**0.022*****	**0.027*****	**0.027*****	**0.017*****	**0.015*****
	(0.004)	(0.003)	(0.005)	(0.005)	(0.004)	(0.002)
Patent information						
PatentValue	**0.001***	0.000	**0.001***	**0.001***	**0.001****	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GreenPatents		−0.129		−3.687		−1.171
		(1.519)		(2.907)		(1.117)
PatentValue · GreenPatents		**−0.125***		**−0.265***		**−0.028***
		(0.093)		(0.196)		(0.017)
Control variables						
BookToMarket	**−0.009*****	**−0.011*****	**−0.005****	**−0.005****	**−0.010****	**−0.012****
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
MarketCap	**0.449*****	**0.570*****	**0.447*****	**0.606*****	**0.603*****	**0.883*****
	(0.083)	(0.065)	(0.085)	(0.117)	(0.067)	(0.070)
TotalLiabilities	**−0.114*****	**−0.244*****	**−0.105*****	**−0.114*****	**−0.145*****	**−0.297*****
	(0.026)	(0.020)	(0.027)	(0.034)	(0.024)	(0.019)
ROA	**0.444*****	**0.275*****	**0.430*****	**0.422*****	**0.498*****	**0.274*****
	(0.017)	(0.013)	(0.018)	(0.019)	(0.017)	(0.013)
σ_{ROA}	**−0.951*****	**−0.127*****	**−0.505*****	**−0.544*****	**−0.957*****	0.054
	(0.076)	(0.050)	(0.069)	(0.072)	(0.073)	(0.042)
Alpha	**−0.052*****	**−0.039*****	**−0.043***	**−0.045***	**−0.072*****	**−0.017*****
	(0.018)	(0.005)	(0.024)	(0.027)	(0.017)	(0.010)
Beta	**−0.001*****	**−0.000*****	**−0.000***	−0.000	**−0.001*****	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.418	0.418	0.513	0.514	0.484	0.485
Adj. R^2	0.415	0.415	0.513	0.512	0.481	0.482
Num. Obs.	10,695	10,695	10,695	10,695	10,695	10,695
F-stat	154.6	151.7	220.3	217.8	202.1	198.6
VIF	1.717	1.718	2.343	2.346	1.937	1.940

Note: This table reports the estimation results of Eq. (5.5) on the effect of green energy on future firm performance. Definitions of all the variables are provided in Table 5.1. The significance of the coefficients is reported by using Newey-West standard errors, which are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, using a two-sided t-test. $^+$Represents a multiplication by 100 for representation purposes. Goodness of fit is evaluated by the $R^2$and Adj. R^2. VIF represents the highest Variance Inflation Factor amongst the included variables of the model

$^{Y+3}$. In line with Hypothesis 1B, this result indicates that an increase in the proportion of green energy innovation significantly reduces future firm performance. Furthermore, our control variables are significantly associated with the *ROA* measures, and report a relatively high R^2, ranging between 40% and 50%. Table 5.5 displays the association between innovation and firm value, measured by Tobin's Q. We again show that *PatentValue* positively affects future firm value, in the 2-year and 3-year ahead. We however only find a negative interaction term for *PatentValue* · *GreenPatents* in the 3-year ahead model.

Together with the results from Tables 5.4 and 5.5, we thus find evidence in favor of the crowding-out hypotheses, showing that green energy projects are wealth-decreasing, such that innovative firms crowd out valuable non-green projects for the less-valuable green ones. To show that our results are not driven by the choice of performance measure, we run the same models with different dependent variables. Table 5.6 shows the impact of green energy innovation *PatentValue* · *GreenPatents* on the logarithm of the total sales (log(*Sales*)) in the three consecutive years. While we find a positive association between *PatentValue* and our dependent variables, we report a negative relationship between log(*Sales*) and *PatentValue* · *GreenPatents*.

Altogether, our results provide support for Hypothesis 1B in that green energy innovation has a negative effect on future performance. This implies that when a firm invests in green innovation, the firm acts at odds with its function as a wealth-maximizing entity and crowds out more profitable non-green projects.

5.4.3 Investors' Reaction to Green Innovation

If we assume that investors are rational economic agents, we expect them to understand the underlying value behind patents and to incorporate this expectation into their stock valuation. Following this reasoning and the results in the previous section, investors should react negatively around and after the granting of green energy patents. Table 5.7 reports the results of Eq. (5.7), and shows no significant association between *PatentValue* and the direct investors' reaction. Yet, we find that the coefficient of our interaction variable *PatentValue* · *GreenPatents* is negatively and significant at a 95% confidence level. This finding is particularly important as they show that investors are informed agents who understand the value of patents and their consequences on firm's performance and value. As a result, they immediately negatively react to the granting of patents of green energy projects.

We thus find clear confirmation of the downward effect of green energy innovation on the immediate market reaction of the firm's stock price to the granting of green energy patents. We now further test whether this effect remains for the delayed effect of green innovation on the firm's cumulative abnormal return over the 60 and 180 days after the announcement of the patent, starting 2 days after the event date. Models (4) and (6) of Table 5.7 show that, compared to the immediate effect, the magnitude of the delayed effect of green energy innovation on the firm's stock price increases. The coefficient of *PatentValue* · *GreenPatents* is four (15) times more negative for the delayed effect over the 62 (180) days after the event date. This

Table 5.5 Future firm value and green energy innovation

Future market value	$\log(TobQ^{Y+1})$		$\log(TobQ^{Y+2})$		$\log(TobQ^{Y+3})$	
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
(Intercept)	**0.294***	**0.834*****	**0.540*****	**0.544*****	**0.617*****	**0.625*****
	(0.161)	(0.102)	(0.134)	(0.134)	(0.180)	(0.179)
Patent information						
PatentValue	−0.001	−0.002	**0.005***	**0.005***	**0.004***	**0.003****
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)
GreenPatents^{+}		**−61.430***		−9.789		−31.756
		(33.580)		(53.723)		(67.700)
PatentValue. GreenPatents^{+}		2.275		−2.406		**−4.871***
		(2.391)		(3.820)		(2.773)
Control variables						
BookToMarket	**0.044*****	**0.027*****	−0.001	−0.001	**0.106****	**0.022****
	(0.009)	(0.008)	(0.011)	(0.011)	(0.014)	(0.012)
MarketCap	**2.855*****	**2.584*****	1.325	1.327	**3.556*****	**3.528*****
	(0.816)	(0.668)	(0.859)	(0.858)	(1.082)	(1.082)
TotalLiabilities	**−1.102*****	**−1.325*****	**−1.617*****	**−1.617*****	**−1.817*****	**−1.264*****
	(0.250)	(0.241)	(0.304)	(0.304)	(0.366)	(0.351)
log(*TobQ*)	**0.928*****	**0.893*****	**0.731*****	**0.731*****	**0.791*****	**0.679*****
	(0.011)	(0.011)	(0.014)	(0.014)	(0.014)	(0.012)
σ_{ROA}	**2.014*****	**1.464*****	**0.917***	**0.917***	**4.715*****	**1.025***
	(0.478)	(0.451)	(0.525)	(0.525)	(0.686)	(0.572)
Alpha	**−0.587*****	**−0.579*****	**−0.471*****	**−0.471*****	**−0.486*****	**−0.463*****
	(0.061)	(0.052)	(0.053)	(0.055)	(0.032)	(0.028)
Beta	**0.060*****	**0.061*****	−0.008	−0.008	−0.007	**−0.029*****
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.837	0.831	0.718	0.718	0.649	0.643
Adj. R^2	0.836	0.830	0.717	0.716	0.648	0.641
Num. Obs.	10,695	10,695	10,695	10,695	10,695	10,695
F-stat	349.5	342.9	231.1	226.6	182.2	178.7
VIF	2.782	2.778	2.214	2.219	1.996	1.997

Note: This table reports the estimation results of Eq. (5.6) on the effect of green energy on future firm performance. Definitions of all the variables are provided in Table 5.1. The significance of the coefficients is reported by using Newey-West standard errors, which are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, using a two-sided t-test. $^{+}$Represents a multiplication by 100 for representation purposes. Goodness of fit is evaluated by the $R^2$and Adj. R^2. VIF represents the highest Variance Inflation Factor amongst the included variables of the model

Table 5.6 Robustness: Future sales and green energy innovation

Future sales	log($Sales_{Y+1}$) Model (1)	Model (2)	log($Sales_{Y+2}$) Model (3)	Model (4)	log($Sales_{Y+3}$) Model (5)	Model (6)
PatentValue	**0.038****	**0.046*****	**0.029***	**0.037****	0.010	0.017
	(0.015)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
GreenPatents		**−0.006***		**−0.006*****		**−0.006*****
		(0.001)		(0.001)		(0.001)
PatentValue. GreenPatents+		**−18.168*****		**−21.579*****		**−19.540*****
		(6.131)		(6.251)		(6.272)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.626	0.630	0.625	0.629	0.635	0.638
Adj. R^2	0.624	0.629	0.623	0.0627	0.633	0.637
Num. Obs.	10,695	10,695	10,695	10,695	10,695	10,695

Note: This table reports additional robust evidence on the effect of green energy on future firm performance. Definitions of all the variables are provided in Table 5.1. The significance of the coefficients is reported by using Newey-West standard errors, which are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, using a two-sided t-test. +Represents a multiplication by 100 for representation purposes. Goodness of fit is evaluated by the R^2 and Adj. R^2. VIF represents the highest Variance Inflation Factor amongst the included variables of the model

increasing coefficient indicates that stock prices continue to drift down long after the patent granting date.[6] It must be taken into account that, once we correct for green energy innovation, the coefficient of the *PatentValue* variable becomes insignificant. Overall these results confirm Hypothesis H2A that investors understand the value attached to innovation and, not only immediately react to the patenting of innovative projects, but continue to adjust prices over longer periods.

5.5 Conclusion

Innovation through patents is key for firms to create and maintain a competitive advantage. Although prior literature reports that innovation positively explains firm performance, there exists conflicting evidence on how innovation in green energy technology affects future firm profitability and value. We shed a new light on this ambiguity by investigating the impact of green patents on firm performance and

[6]Multiple other time windows around and after the patent granting date were used, and qualitatively similar results are obtained. These results are not reported her for presentation purposes, but are available upon request.

Table 5.7 Investors' reaction to green energy innovation

	ACAR[−1; +1]		ACAR[+2; +62]		ACAR[+2; +180]	
Market reaction	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
(Intercept)	**0.024****	**0.024****	−0.069	−0.068	**−0.253*****	**−0.251*****
	(0.011)	(0.011)	(0.060)	(0.060)	(0.114)	(0.114)
Patent information						
PatentValue⁺	0.002	0.002	0.016	0.014	0.023	0.017
	(0.004)	(0.004)	(0.021)	(0.021)	(0.040)	(0.040)
GreenPatents	−0.000	0.000	**−0.001***	−0.001	**−0.001*****	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
PatentValue. GreenPatents		**−0.002****		**−0.009****		**−0.029****
		(0.001)		(0.005)		(0.010)
Control variables						
BookToMarket	**−0.002*****	**−0.002*****	**0.076*****	**0.076*****	**0.231*****	**0.231*****
	(0.001)	(0.001)	(0.006)	(0.006)	(0.011)	(0.011)
MarketCap	**16.404*****	**16.405*****	−74.373	−74.370	**−211.404*****	**−211.969*****
	(8.851)	(8.850)	(47.130)	(47.127)	(89.349)	(89.321)
ROA	**0.039*****	**0.037*****	−0.053	−0.060	**−0.776*****	**−0.800*****
	(0.012)	(0.012)	(0.062)	(0.062)	(0.117)	(0.118)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.012	0.013	0.034	0.034	0.080	0.081
Adj. R^2	0.008	0.008	0.030	0.030	0.076	0.076
Num. Obs.	10,695	10,695	10,695	10,695	10,695	10,695
F-stat	2.894	2.939	8.137	8.019	20.121	19.857
VIF	1.013	1.013	1.035	1.035	1.087	1.088

Note: This table reports the estimation results of Eq. (5.7), which tests the effect of (green energy) innovation on the market reaction around the patent granting date. Definitions of all the variables are provided in Table 5.1. The significance of the coefficients is reported by using Newey-West standard errors, which are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, using a two-sided t-test. ⁺Represents a multiplication by 100 for representation purposes. Goodness of fit is evaluated by the R^2 and Adj. R^2. VIF represents the highest Variance Inflation Factor amongst the included variables of the model

testing how investors react to a firm's green innovative efforts. Based on a sample of about 130,000 patents granted to 212 firms issued between 1975 and 2006, we find that innovation significantly increases a firm's value and future operational performance. However, we show that this is not the case for green energy innovation and report that innovation in green energy reduces future firm performance and value. Our analyses also show that stock prices negatively react to the news of green energy innovation and that investors' reaction is not only immediate, but also long-lasting.

Our results are key for managers and shareholders to answer the widely debated question of whether firms gain economic opportunities by investing in green energy innovation. Our analyses suggest that firms sacrifice more profitable and value enhancing non-green projects for green innovation, thereby leading to a reduction in the firm value. In doing so, these firms generally act as wealth-decreasing entities. We also uncover that investors understand the impact of green energy innovation on firms' financial performance and react negatively to the granting of green energy patents. In fact, investors negatively react to the granting of green energy patents, and stock prices continue to drift down for more than 180 days.

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6 Analysing the Relationship Between Oil Prices and Basic Petrochemical Feedstocks

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Abstract

In this paper we analyse the relationship between crude oil prices and prices of basic petrochemical feedstock. In particular, we estimate dynamic effects of Brent oil prices on naphtha, benzene, ethylene, propylene, acrylonitrile (ACN), vinyl chloride polymer (VCM), purified terephthalic acid (PTA), and monoethylene glycol (MEG). We first analyse cointegration properties among these variables using bounds testing approach. Then we estimate error correction models to assess long- and short-run effects of oil price changes on prices of these petrochemical feedstocks. We find that naphtha prices move one to one with oil prices in the long run. Prices of other feedstock react less than unity in the long run. We also find that only prices of benzene and naphtha react more than unity in the short run whereas prices of propylene and ethylene react less than unity to changes in oil prices.

This study fills a major gap in the empirical literature. Although the dynamic interactions among oil prices and fuels as well as other macroeconomic and financial variables have been widely investigated in the literature, the relationships between oil and petrochemicals prices have not been thoroughly analysed. Second, the results of this study have clear policy implications. In particular, we find that prices of basic petrochemicals do not move one to one with oil prices. This finding implies that oil price fluctuations are not fully transmitted to prices of industrial products, and hence oil price changes will have only limited effects on economy. Furthermore, this result also implies that

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oil companies and oil exporting countries may use petrochemical goods as hedging instruments against oil price falls.

Keywords
Oil prices · Petrochemicals' prices · Cointegration · Granger-causality

6.1 Introduction

The relationship between oil prices and economic variables has attracted a huge interest of economists after the 1973 oil crisis. In his seminal paper, Hamilton (1983) has examined the relationship between oil prices and a number of US macroeconomic variables, including output, unemployment, price level, and financial variables, and found that oil prices have strong causal effects on most of the variables considered. He concluded that oil shocks were a contributing factor in some US recessions. Since then, many researchers have examined the effects of oil price changes on many economic variables across various countries and presented results supporting Hamilton's conclusion that oil price changes have significant effects on economy (see, among others, Gisser and Goodwin 1986; Bernanke et al. 1997; Sadorsky 1999; Kilian 2008; Arslan-Ayaydin and Khagleeva 2013; Morana 2017).

Kilian (2008) identifies four direct channels through which oil price changes affect economic variables. First, higher energy prices reduce discretionary income as changes in price increases energy bills. Second, higher prices create uncertainty, which in turn, has a negative impact on purchases of durable consumer goods and business investments. Third, consumers may increase precautionary savings in the face of higher prices. Fourth, higher energy prices increase operating cost of energy-using durable goods and thus reduce demand for these goods. In addition to these direct channels, oil price changes may affect economic variables indirectly as well. For example, an increase in oil prices will naturally increase relative prices of energy-intensive goods, causing to a substitution of these goods with alternatives. Similarly, a fall in the demand for energy-intensive durable goods will cause reallocation of capital and labour from these sectors to other sectors, which may not be as productive as the energy-intensive goods. The effectiveness of these alternative channels crucially depends on the response of energy intensive goods to oil price changes. Therefore, the effects of oil prices on price of various goods have been attracting increasing interest of economists.

Majority of the empirical research has focused mainly on aggregate macroeconomic variables such as total output, unemployment, inflation, and stock price indices. Few researchers have examined reaction of disaggregate economic variables to oil price changes. For example, Pindyck and Rotemberg (1990), Baffes (2007, 2010), Harri et al. (2009), Nazlioglu and Soytas (2012), among others, study the reaction of commodity prices to oil prices. Karagiannis et al. (2015) and Moutinho et al. (2017) investigate the effects of oil prices on fuel prices. Lee and Shawn (2002) investigate dynamic effects of oil price shocks on various industries. They find that oil price shocks mainly reduce supply of industries that have larger cost share of oil, such as petroleum refinery and industrial chemicals. In other industries, oil price shocks affect mainly demand. On the other hand, Castro and Jiménez-Rodríguez (2017) concentrate on the effects of oil prices on producer and consumer prices at industrial level. In particular, they analyse how price indices of 19 industries react to oil price changes and conclude that oil price pass-through to consumer prices is generally very low, and relevant only for chemical and metal products. However, response of aggregate series to oil price shocks may be biased due to aggregation bias (see, for example, Imbs et al. 2005). The effects of oil prices on commodity prices crucially depend on their energy intensities. Hence, various commodities will react to oil price changes differently depending on their energy intensities. In fact, results of Lee and Shawn (2002) and Castro and Jiménez-Rodríguez (2017) imply that oil price changes have greater effect on energy intensive industries, in particular, refinery and chemical industries. The failure to take account of heterogeneity of responses may lead to heterogeneity bias in estimates. Therefore, examination of the effects of oil prices on disaggregated series contributes to our understanding of propagation of oil price shocks.

Crude oil is the most important primary energy source. In fact, according to BP's Statistical Review of World Energy 2016, crude oil covered almost one third of world's total primary energy consumption in 2015. Its share was about 32.9%, followed by coal (29.2%), and natural gas (23.8%). Naturally, an increase in energy prices will eventually increase production costs of all commodities, depending on their energy intensity. However, crude oil has alternative uses as well. In particular, oil is the most important input in chemical industry, particularly for petrochemical products. As petrochemicals are widely used as an intermediate input in almost all industries, an increase in petrochemical prices will increase input costs of these industries irrespective of their energy intensities.

Derived mainly from petroleum and natural gas, petrochemicals are the raw materials out of which come gasoline, plastics, synthetic rubber, synthetic fibres, detergents, fertilisers, pesticides, drugs, and hundreds of other commonly used products (Soday 1951; The Boom in Petrochemicals 1957). Therefore, the petrochemical industry has been considered as the "industry's industry" or "the central industry of modern civilization" (Ilgen 1983). Technological and scientific progress greatly stimulated interest in the utilisation of petroleum hydrocarbons as a basic raw material for the production of synthetic organic chemicals. Coupled with vast and relatively cheap supply of oil and gas, this made petrochemicals economically more competitive than any other natural material. As a result, petrochemical products have replaced many traditional materials, including natural fibres, rubber, metal and wood (see, for example, Soday 1951; Lloyd 1954). Nowadays, petrochemical products are widely used in almost all industries, ranging from textile to transport vehicles, food, agriculture, electronics, machine building, construction, and services. Furthermore, strong demand growth is expected for petrochemicals feedstock in the future (OPEC 2016). While industry observers and professionals constantly emphasize importance of crude oil prices for petrochemical products, dynamic effects of oil price variations on petrochemicals are not investigated yet.[1] Therefore, it would be interesting to examine how petrochemical prices react to oil price changes.

In this paper, we examine the effects of oil prices on disaggregated petrochemical feedstock prices. We first test stationarity properties of the variables and then employ bounds testing procedure proposed by Pesaran et al. (2001) to investigate cointegration among price series of these commodities. As the cointegration test results suggest that all the variables are cointegrated, we proceed to estimate an error-correction model (ECM) for the variables under consideration. Using estimate long-run relationships and ECMs we discuss long and short-run effects of oil price changes. Furthermore, in order to see whether the effects of oil prices vary over time, we estimate the cointegration vector using rolling window analysis.

Our results provide strong evidence of cointegration between crude oil prices and petrochemical products' prices. However, the estimated cointegration relationship implies that most petrochemical prices react less than unity to oil price changes. Furthermore, rolling window estimates suggest that the cointegration coefficient may have varied during the analysed period, implying a nonlinear relationship among the variables. On the other hand, we find that reactions of petrochemical prices to crude prices are not dependent on oil prices. Overall, our results imply that oil companies and oil exporting countries can use petrochemical goods as a hedging instrument against oil price falls.

The rest of the chapter is organized as follows. In the next section we present and discuss data used in this paper. In Sect. 6.3, we briefly discuss the econometric methodology. Section 6.4 presents estimation results, and Sect. 6.5 concludes.

6.2 Data

In this paper, we analyse the dynamic relationship among crude oil prices and basic petrochemicals including naphtha, benzene, ethylene, propylene, acrylonitrile (ACN), vinyl chloride polymer (VCM), purified terephthalic acid (PTA), and monoethylene glycol (MEG). We chose these specific products as they are the most important petrochemical feedstock, being the basic building blocks for many downstream chemicals, plastics and synthetic fibres (see, for example, Soday 1951). Monthly data covering the period January 2000–February 2015 is retrieved from Platts database.[2] All price series are in USD per metric tons. As crude oil price we take the Brent price, which is the most relevant for the petrochemicals industry. We take natural logarithms of variables before formal tests. Figure 6.1 below plots graph of data used in this paper.

As can readily be seen from the figure, prices of all commodities fluctuated widely during the analysed period. This period has witnessed quite different dynamics in the data. All commodity prices were relatively stable and fluctuated around

[1] See, for example, Geipel-Kern (2015) and McKinsey (2016).

[2] The choice of the sample period is dictated by data availability.

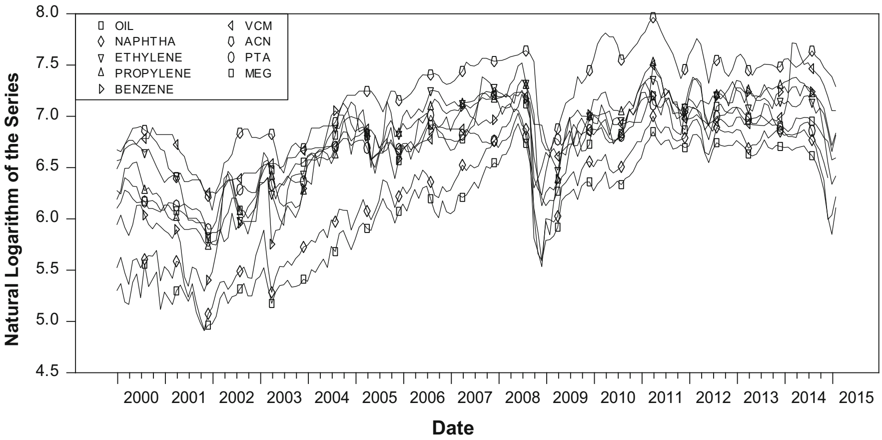

Fig. 6.1 Time series graph of data

their mean during 2000. After a decline in 2001, commodity prices exhibited an upward trend starting from late 2001/early 2002 till the financial crisis in 2008. While prices of naphtha and oil quickly recovered and surpassed their respective levels in 2000, recovery in prices of other commodity prices were relatively slowly. Rise in commodity prices continued throughout 2008 and reached to historically high levels by midyear. The 2008–2009 financial crises caused to a sharp price fall. However, prices recovered quickly and returned to pre-crisis levels by late 2011 and stayed at these high levels till mid-2014. The end of the sample period had witnessed another sharp price decline.

It is also interesting to note that only naphtha prices move closely to crude oil prices. This is not surprising as naphtha is one of the initial products obtained from refining of crude oil and many petrochemicals as well as fuels are derived from naphtha. Additionally, petrochemical products may be derived from natural gas, gas liquids and other raw materials such as coal or biomasses.

Table 6.1 presents descriptive statistics of the data. Computed statistics also support that commodity prices, especially prices of benzene, naphtha, ethylene, propylene and crude oil have fluctuated widely during the analysed period (see also descriptive statistics of price changes presented in the Table 6.7 in Appendix). Only the price of vinyl chloride polymer (VCM) is positively skewed whereas prices of other commodities do not suffer from excess skewness. In addition, distributions of all price series are platykurtic (with a lower peak and fat tails) except for VCM, which is leptokurtic (with a higher peak and thin tails) and purified terephthalic acid (PTA), which is mesokurtic (with a normal peak and tails).

As the commodity prices exhibited quite different dynamics during the analysed period, our sample provides a unique and interesting period for analysing interrelationship between the prices of crude oil and petrochemicals.

Table 6.1 Descriptive statistics

Series	Average	Min	Max	Std. deviation	Skewness	Kurtosis
Oil	493.3	134.4	1011.9	248.5	0.190 [0.30]	−1.345 [0.00]
Naphtha	573.3	136.0	1119.0	275.9	0.124 [0.50]	−1.361 [0.00]
Benzene	865.7	197.5	1525.0	382.8	−0.209 [0.25]	−1.310 [0.00]
Ethylene	996.9	340.0	1831.0	357.1	−0.187 [0.31]	−0.955 [0.01]
Propylene	986.4	305.0	1831.4	388.9	−0.159 [0.38]	−1.170 [0.00]
ACN	1446.3	435.0	2852.5	553.4	0.074 [0.68]	−0.889 [0.02]
VCM	983.3	512.5	2224.5	302.8	1.430 [0.00]	3.061 [0.00]
PTA	826.7	361.7	1515.3	249.0	0.067 [0.72]	−0.541 [0.15]
MEG	853.9	310.0	1597.5	295.7	0.014 [0.94]	−0.843 [0.02]

Notes: Prices are in USD per metric ton. Figures in square brackets are p-values of the test statistic

6.3 Econometric Methodology

Consider the following autoregressive distributed lag (ARDL) model:

$$P_t = \alpha + \sum_{i=0}^{m} \beta_i Op_{t-i} + \sum_{j=1}^{n} \gamma_j P_{t-j} + u_t \tag{6.1}$$

where P_t is the price of petrochemicals and Op_t is crude oil price, both natural logarithms, u_t is the disturbance term, and α, β_i and γ_j are parameters to be estimated. Other most frequently used dynamic models such as partial adjustment model (PAM) and distributed lag (DL) model can be obtained by a convenient parameter restriction on the ARDL model. For example, setting $\gamma_j = 0$ for all $n = 1, \ldots, r$ gives the DL model and setting $\gamma_j = 0$ for $j = 2, \ldots, n$ gives the PAM.

As the ARDL model does not put any restriction on parameters, it allows for more flexibility regarding modelling persistence of the effects of changes in the explanatory variables. However, it may have a large number of parameters to be estimated, which can pose some troubles in small data spans. The coefficient on contemporaneous value, i.e., β_0 is the short-run response. The long-run response can be computed as $\sum_{i=0}^{m} \beta_i / \left(1 - \sum_{j=1}^{n} \gamma_j\right)$ in the ARDL model.

The ARDL model given above requires all the variables to be stationary. Estimated parameters may be spurious if the variables are unit root processes but not co-integrated (e.g., Granger and Newbold 1974; Engle and Granger 1987).

Therefore, one must test stochastic properties of the series and adopt an appropriate modelling strategy to obtain reliable results. Pesaran et al. (2001) proposes a cointegration test that allows for testing cointegration and estimating relationship between levels of variables irrespective order of integration. This procedure has been proved to be very useful given low power of conventional unit root tests. Therefore, we consider the cointegration test of Pesaran et al. (2001), which is based on the following equation:

$$\Delta P_t = \alpha_0 + \sum_{i=0}^{m} \beta_i \Delta Op_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta Op_{t-j} + \eta_1 Op_{t-1} + \eta_2 P_{t-1} + \epsilon_t \tag{6.2}$$

where Δ is the difference operator, i.e., $\Delta X_t = X_t - X_{t-1}$. The null hypothesis of no cointegration can be tested as a joint significance of the lagged level variables based on F-statistic for testing the null hypothesis:

$$\begin{array}{ll} & H_0 : \eta_1 = \eta_2 = 0 \\ \text{against the alternative} & \\ & H_1 : \eta_1 \neq 0 \quad \text{and} \quad \eta_2 \neq 0 \end{array} \tag{6.3}$$

As this testing procedure does not require all the variables to be I(1), Pesaran et al. (2001) tabulate two sets of critical values, denoted as lower and upper bounds. The lower bound assumes that the variables are I(0) and the upper bound assumes that the variables are I(1). If the computed F-statistic exceeds the upper critical bound, the null hypothesis H_0 is rejected, implying that the variables are co-integrated. If the computed F-statistic is below the lower bound, the null is not rejected and therefore the variables are not co-integrated. If, however, the computed F-statistic falls within these bounds, the result is inconclusive and one must return to other conventional cointegration tests.

If cointegration is established, the long-run relationship in the levels of the variables is estimated as in Eq. (6.4):

$$P_t = \alpha + \beta Op_t + \varepsilon_t \tag{6.4}$$

with error-correction model (ECM) for short-run relationship:

$$\Delta P_t = \alpha_0 + \sum_{i=0}^{m} \beta_i \Delta Op_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta P_{t-j} + \theta ECT_{t-1} + \vartheta_t \tag{6.5}$$

where the error-correction term $ECT_{t-1}$is the lagged error term $\widehat{\varepsilon}_{t-1}$ obtained from the long-run equation. The long-run response of petrochemical prices to crude oil prices is given by β in Eq. (6.4) whereas the short-run response is computed as $\sum_{i=0}^{m} \beta_i$ in Eq. (6.5).

The coefficient on the error correction term must be negative to correct for deviations from the long-run equilibrium relationship. This implies that $\theta < 0$ in

Eq. (6.5) above. The negative sign of the error correction term implies the presence of long-run relationship among the variables. Therefore, the presence of the level relationship can alternatively be established by testing the following null hypothesis:

$$\begin{array}{rl} & H_0 : \theta \geq 0 \\ \text{against the alternative :} & \\ & H_1 : \theta < 0 \end{array} \quad (6.6)$$

This test can be carried out by ordinary t-statistics after estimating Eq. (6.5). Rejection of this hypothesis implies the presence of long-run equilibrium relationship. Pesaran et al. (2001) also reports lower and upper bounds for the t-statistics.

After estimating ECM model given in Eq. (6.5), one can easily conduct Granger causality tests. In particular, we carry out three types of Granger-causality tests, namely, short-run, long-run, and strong Granger-causality. These causality tests are carried out by testing following hypotheses:

	Null hypothesis	Alternative	
Short-run causality test	$H_0 : \beta_i = 0$	$H_1 : \beta_i \neq 0, i = 0, 1, \ldots m$	(a)
Long-run causality test	$H_0 : \theta = 0$	$H_1 : \theta < 0$	(b)
Strong (short-and long-run) causality	$H_0 : \beta_0 = \theta = 0$	$H_1 : \beta_i \neq 0, i = 0, 1, \ldots m, \ \ \theta = 0$	(c)

(6.7)

6.4 Estimation Results

Before testing the relationship among the variables, we first test stationarity of data. In order to test stochastic properties of the series, we apply a battery of unit root tests. We employ the KPSS (Kwiatkowski et al. 1992) test in addition to the conventional ADF (Dickey and Fuller 1979) and PP (Phillips and Perron 1988) tests. The KPSS test differs from the ADF and PP tests in that the former assumes that the series under investigation are stationary under the null hypothesis whereas the latter two tests assume that series have a unit root under the null hypothesis. In addition, considering that economic recession in 2008–2009 may have caused to break in the trend of the series, we also apply the Zivot and Andrews (1992) unit root test, which allows for a break in the deterministic components of the series. The results of these tests are reported in Table 6.2.

Table 6.2 shows that the unit root tests suggest that crude oil, naphtha, benzene, ACN and MEG are I(1) processes. The tests also provide mixed evidence about stationarity properties of ethylene, propylene, VCM and PTA. Therefore, we proceed to estimate cointegration among the variables using bounds tests of Pesaran et al. (2001). Test results are presented in Table 6.3.

The cointegration test results imply that all the petrochemical price series are co-integrated with crude oil price when the latter is considered as the causing

Table 6.2 Stationarity tests

	ADF test	PP test	KPSS test	ZA test
Levels				
Crude oil	−2.124(1)	−2.031(1)	0.745	−3.226(0)
Naphtha	−3.140(1)	−2.650(1)	0.687	−4.574(1)
Ethylene	−3.758(1)*	−2.919(1)	0.583	−5.548(1)*
Benzene	−3.314(1)	−2.796(1)	0.614	−4.697(1)
Propylene	−4.169(1)**	−2.801(1)	0.634	−5.572(1)**
VCM	−3.905(4)*	−3.196(4)	0.092**	−3.974(1)
ACN	−3.323(1)	−2.325(1)	0.699	−4.366(1)
PTA	−3.073(1)	−2.156(1)	0.892	−8.248(1)*
MEG	−3.323(1)	−2.498(1)	0.678	−4.775(1)
First differences				
Crude oil	−9.052(1)**	−12.886(1)**	0.060**	−13.145(0)**
Naphtha	−9.410(1)**	−11.515(1)**	0.043**	−11.737(0)**
Ethylene	−9.510(1)**	−9.945(1)**	0.035**	−9.592(2)**
Benzene	−9.067(1)**	−11.206(1)**	0.036**	−11.472(0)**
Propylene	−8.548(0)**	−8.620(0)**	0.046**	−8.785(0)**
VCM	−5.734(3)**	−10.652(0)**	0.030**	−10.107(0)**
ACN	−8.262(0)**	−8.332(0)**	0.063**	−8.537(0)**
PTA	−9.177(0)**	−9.256(0)**	0.056**	−9.894(1)**
MEG	−9.414(0)**	−9.494(0)**	0.052**	−9.635(0)**
Critical values				
%5	−3.435	−3.435	0.146	−5.08
%1	−4.011	−4.011	0.216	−5.57

Notes: Figures in parenthesis denote number of augmentation terms. Number of augmentation terms was chosen so as to remove any significant residual correlation. * and ** denote rejection of the null hypothesis of unit root at 5% and 1% significance levels for the ADF and PP tests and no rejection of the null hypothesis of stationarity at 90% and 95% percent significance levels for the KPSS test

variable. Based on these tests we proceed to estimate error correction models and carry out Granger-causality tests, results of which are provided below in Table 6.4.

Our results imply that ethylene, VCM and MEG is not a Granger-cause of crude oil prices in the long run. This, in turn, implies that prices of these commodities have no predictive power for crude oil prices in the long run. However, changes in prices of these commodities can be used to predict oil price changes in the short run. For all other petrochemicals, we find a strong evidence of bidirectional Granger-causality both in the short and long run. Estimated ECMs for petrochemical products are provided in Table 6.8 in the Appendix A. Table 6.5 below summarizes long-run and short-run responses of petrochemicals' prices to crude oil price.

The estimated responses of petrochemical prices both in the short and long runs are consistent with expectations and results of previous studies (see, for example, Lee and Shawn 2002; McKinsey 2016; Castro and Jiménez-Rodríguez 2017). The estimated long-run responses of all petrochemicals to crude all price are statistically

Table 6.3 Cointegration test results

Variables				
Dependent	Independent	F statistic	t-statistic	
Naphtha	Crude oil	10.920***	−4.633***	
Crude oil	Naphtha	38.267***	−8.628***	
Ethylene	Crude oil	7.211**	−3.800**	
Crude oil	Ethylene	3.995	−2.823	
Benzene	Crude oil	9.598***	−4.271**	
Crude oil	Benzene	5.960**	−3.323	
Propylene	Crude oil	14.586***	−5.398***	
Crude Oil	Propylene	7.539**	−3.892**	
VCM	Crude oil	9.171***	−4.262***	
Crude oil	VCM	1.926	−0.913	
ACN	Crude oil	10.841***	−4.658***	
Crude oil	ACN	7.140**	−3.744**	
PTA	Crude oil	11.354***	−4.632***	
Crude oil	PTA	9.494***	−3.939**	
MEG	Crude oil	9.734***	−4.402***	
Crude oil	MEG	3.938	−2.790	
Critical values	F statistic		t statistic	
Significance Level	I(0)	I(1)	I(0)	I(1)
%10	4.04	4.78	−3.13	−3.40
%5	4.94	5.73	−3.41	−3.69
%1	6.84	7.84	−3.96	−4.26

Notes: *, ** and ***, denote rejection of the null hypothesis of no cointegration at 10%, 5% and 1% significance level, respectively

significantly less than unity. This implies that petrochemical prices do not move one to one with oil prices. Only naphtha prices respond to crude prices near unity in the long run. The estimated coefficient implies that 1% increase in crude prices will cause naphtha prices to increase by 0.95% in the long run. However, naphtha and benzene prices react to oil price changes more than unity in the short run. All other petrochemical products react to oil price changes less than unity both in the short and long run. Although changes in crude oil price have statistically significant effects on petrochemical prices both in the short and long runs, our results imply that these effects are not uniform across all commodities. Furthermore, the estimated adjustment coefficients (the coefficient of the error correction term) imply that changes in oil prices may not have an immediate impact on the petrochemical prices, which also varies considerably across commodities (see Table 6.8 in appendix). All in all, these findings support observations that the impact of oil price changes is differentiated across chemicals (McKinsey 2016).

In order to see how the relationships among crude price and petrochemicals' prices evolve over time, we run a rolling window estimate of the level relationship. Window size is set to 60 in each step. In particular, we use first 60 observations and estimate a regression of petrochemical prices on a constant and crude price, and

Table 6.4 Granger-causality test results

Null hypotheses	Short-run causality:	Long run causality	Strong (short + long run) causality
Crude oil does not Granger-cause naphtha	323.880***	−4.633***	216.000***
Naphtha does not Granger-cause crude oil	639.921***	−8.628***	349.318***
Crude oil does not Granger-cause ethylene	26.003***	−3.801***	23.835***
Ethylene does not Granger-cause crude oil	24.724***	–	–
Crude oil does not Granger-cause benzene	50.237***	−4.271***	37.814***
Benzene does not Granger-cause crude oil	49.527***	−3.323***	36.435***
Crude oil does not Granger-cause propylene	26.598***	−5.398**	32.657***
Propylene does not Grange-cause crude oil	13.092***	−3.892***	11.000***
Crude oil does not Granger-cause VCM	2.812*	−4.262***	11.051***
VCM does not Grange-cause crude oil	2.073**	–	–
Crude oil does not Granger-cause ACN	9.714***	−4.656***	16.970***
ACN does not Grange-cause crude oil	2.729***	−3.744***	3.046***
Crude oil does not Granger-cause PTA	15.872***	−4.632***	14.218***
PTA does not Grange-cause crude oil	4.006***	−3.939***	5.305***
Crude oil does not Granger-cause MEG	19.871***	−4.402***	20.647***
MEG does not Grange-cause crude oil	23.242***	–	–

Notes: *, ** and ***, denote rejection of the null hypothesis of no Granger-causality at 10%, 5% and 1% significance level, respectively

record the slope coefficient. Then, we move both start and end periods by one unit and run the same regression, and again record the slope coefficient. Thus, the first regression is run for the period January 2000–January 2005, the second regression is run for the period February 2000–February 2005. In total, we run 122 regressions. Graph of estimated long-run cointegration coefficients are presented below in Graph 2.

As can be readily seen from Fig. 6.2, variation of the long-run responses of petrochemical products' prices to crude oil price was not uniform. In particular, response of naphtha prices to crude oil price changes is relatively stable whereas

Table 6.5 Long-run and short-run responses of petrochemical prices to crude oil price

Variables	Long-run response			Short-run cumulative response
		95% confidence band		
	Point estimate	Lower band	Upper band	
Naphtha	0.953	0.933	0.973	1.319
Ethylene	0.646	0.595	0.697	0.704
Benzene	0.866	0.807	0.925	1.218
Propylene	0.751	0.706	0.796	0.595
VCM	0.389	0.344	0.434	0.081
ACN	0.693	0.652	0.734	0.303
PTA	0.515	0.481	0.549	0.358
MEG	0.590	0.543	0.637	0.486

benzene's response to oil prices varies considerably. The figure also implies that the long-run relationship between the oil price and petrochemical products' prices may be nonlinear.

In order to analyse further the nature of these relationships, we run estimated coefficients on the level of crude prices as well as on monthly and annual changes. Table 6.6 summarizes the results.

Results reported in the Table 6.6 imply that variation of responses of petrochemical prices to crude oil prices do not depend on the level of crude price. Instead, we find that the variation of long-run relationships depend on oil price changes, whereas long-run (annual) changes are more relevant than short-run (monthly) changes for these variations. All estimated slope coefficients are positive and statistically significant at conventional significance levels. This result implies that the higher the rate of change in oil prices the higher the response of petrochemicals' prices to oil prices. This implies that the rate of transmission of oil prices to petrochemical prices increases with the rate of oil price changes, suggesting a nonlinear relationship depending on the size of oil price changes. Empirical researchers (Hamilton 2003; Rahman and Serletis 2010) mainly focus on nonlinearity depending on the sign of oil price changes. In particular, researchers argue that oil price increases affect macroeconomic variables negatively whereas price falls have no comparable effect on economic variables. Our findings, on the other hand, suggest that the size of oil price changes may also be relevant in explaining such asymmetric effects.

Our results have nice implications for risk diversification of oil producers. In particular, the results imply that oil producers may reduce their risks by investing in petrochemicals, especially in cases of fall in oil prices. In order to see how petrochemicals can be used as a hedging instrument against assume that oil prices fall sharply. First note that petrochemical prices are positively correlated with oil prices, meaning that increases in oil prices cause petrochemical prices to rise and fall in oil prices cause them to fall. However, our results imply that the dependence of petrochemicals price on oil prices is positively correlated with changes in oil prices. This implies that when there is a sharp change in oil prices, this dependence will change sharply as well. Now, a sharp fall in oil prices will cause to a sharp decline in

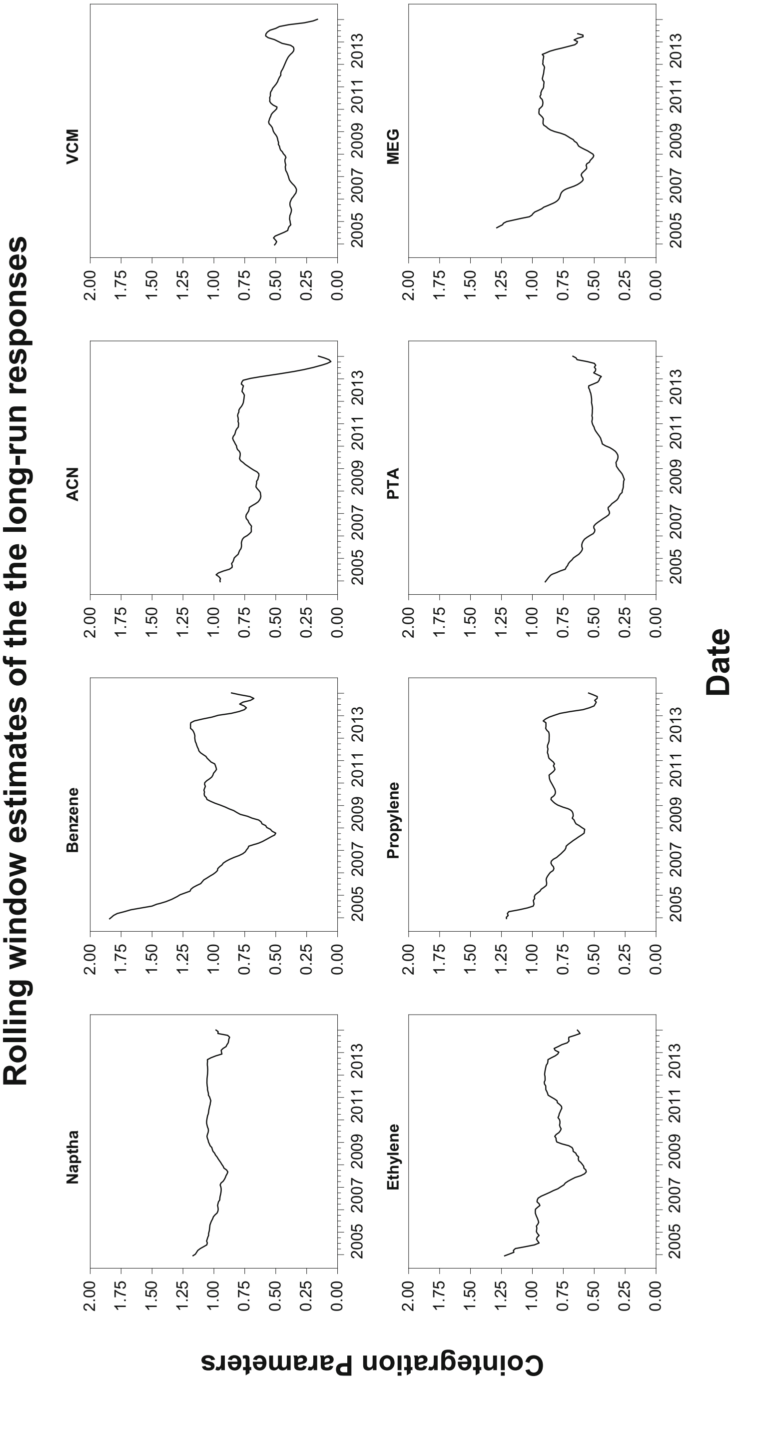

Fig. 6.2 Rolling window estimates of cointegration coefficients

Table 6.6 Dependence of cointegration parameters on oil price changes

	Regression on level		Regression on monthly changes		Regression on annual changes	
	Slope	$\bar{R}^2$	Slope	$\bar{R}^2$	Slope	$\bar{R}^2$
Naphtha	−0.008 (0.019)	−0.007	0.146*** (0.054)	0.049	0.061*** (0.015)	0.115
Ethylene	−0.061 (0.040)	0.011	0.288*** (0.120)	0.038	0.167*** (0.032)	0.183
Benzene	−0.133 (0.083)	0.013	0.560** (0.247)	0.033	0.324*** (0.066)	0.162
Propylene	−0.046 (0.045)	0.003	0.362*** (0.133)	0.051	0.215*** (0.034)	0.247
VCM	0.072*** (0.022)	0.076	0.028 (0.069)	−0.007	0.055*** (0.019)	0.059
ACN	0.011 (0.054)	−0.007	0.447*** (0.158)	0.055	0.249*** (0.041)	0.231
PTA	−0.117*** (0.043)	0.050	0.076 (0.134)	−0.005	0.089** (0.037)	0.037
MEG	0.031 (0.061)	−0.006	0.366** (0.182)	0.025	0.214*** (0.049)	0.130

Notes: Figures in parentheses are standard errors. *, ** and ***, denote significance at 10%, 5% and 1% significance levels, respectively

the dependence of petrochemicals prices on oil prices, implying that sharp fall in oil prices will reduce dependence of petrochemical prices on crude oil prices. Thus, although petrochemical prices will fall with declining oil prices, this fall will not be as sharp as the fall in oil prices as big variations in oil prices are associated with large changes in dependence of petrochemicals' prices. Note also that oil is one of the most important intermediate goods in production of petrochemicals. Thus, while price of oil falls, profit margin of petrochemical plants will increase as cost of inputs fall abruptly but the cost of finished goods (petrochemicals) do not decline one with one with oil prices. Hence, if oil producers operate petrochemical plants as well, a fall in revenue associated with oil prices can be compensated (at least partly) by increasing profit margins of petrochemical plants. Alternatively, increasing oil prices will reduce profitability of petrochemical companies. This, in turn, implies that petrochemical companies may hedge losses with crude prices in the futures markets.

6.5 Conclusion

In this paper, we investigate relationship between crude oil prices and petrochemicals. In particular, we estimate responses of naphtha, benzene, ethylene, propylene, acrylonitrile (ACN), vinyl chloride polymer (VCM), purified terephthalic acid (PTA), and monoethylene glycol (MEG) to Brent dated prices. For this purpose, we first estimate cointegration relationship among these petrochemicals' prices with crude oil prices and find a strong evidence of cointegration. Then we proceed to estimate short and long run responses of these prices series to crude prices. We find that prices of all petrochemicals respond to oil prices less than unity in the long run whereas both the duration and magnitude of responses vary considerably across petrochemical products. On the other hand, only benzene and naphtha react more than unity to crude prices in the short run whereas other petrochemicals respond less than unity in the short run as well. Rolling window estimates of long run relationship indicates that the dependence of petrochemical prices on crude prices may be nonlinear in nature.

Our results have significant implications for both researchers and oil companies. Previous literature mainly focuses on asymmetric response to oil prices whereas asymmetry stems from the sign of change. It is a well-established fact that oil price increases affect economic variables more than oil price falls. However, we find that such asymmetries may arise from the size of oil price changes as well. In particular, our results imply that the dependence of petrochemicals' prices on oil prices varies with the size of oil price changes. This finding also point to profitable hedging options both for oil and petrochemical companies. Future researches may concentrate on the nature of possible nonlinearities in the dynamic interrelationship among prices of crude oil and petrochemical products. For example, one may examine whether positive and negative changes in oil prices have symmetric effects on petrochemical prices. Similarly, one may also examine whether big or small oil price changes have similar impacts on petrochemical prices. Another interesting issue is the dependence of propagation of oil price shocks along the chemicals value chain.

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Appendix

Table 6.7 Descriptive statistics of price changes

Series	Average	Min	Max	Std. deviation	Skewness	Kurtosis
Oil	0.004	−0.441	0.328	0.110	−0.612 [0.00]	1.802 [0.00]
Naphtha	0.004	−0.823	0.468	0.127	−1.653 [0.00]	10.472 [0.00]
Benzene	0.003	−0.962	0.381	0.157	−1.617 [0.00]	8.382 [0.00]
Ethylene	0.002	−0.668	0.498	0.123	−0.347 [0.06]	6.066 [0.00]
Propylene	0.004	−0.679	0.308	0.110	−1.178 [0.00]	8.143 [0.00]
ACN	0.003	−0.523	0.204	0.085	−1.462 [0.00]	7.827 [0.00]
VCM	0.003	−0.214	0.527	0.077	2.013 [0.00]	13.202 [0.00]
PTA	0.002	−0.307	0.232	0.079	−0.410 [0.03]	1.733 [0.00]
MEG	0.002	−0.376	0.281	0.099	−0.089 [0.63]	1.288 [0.00]

Notes: Price change is measured as the first log difference of the series, i.e., $\Delta y_t = \ln(y_t) - \ln(y_{t-1})$. Figures in square brackets are p-values of the test statistic

Table 6.8 Estimates of ECM models

	Naphtha	Ethylene	Benzene	Propylene	VCM	ACN	PTA	MEG
Long-run								
Constant	2.341(0.042)***	4.205(0.106)***	3.118(0.124)***	2.254(0.137)***	4.496(0.139)***	3.001(0.129)***	3.549(0.106)***	3.111(0.146)***
$Poil_t$	0.953(0.010)***	0.646(0.026)***	0.866(0.030)***	0.751(0.023)***	0.389(0.023)***	0.693(0.021)***	0.515(0.017)***	0.590(0.024)***
Short-run								
Constant	−0.001(0.004)	−0.002(0.007)	−0.002(0.009)	0.000(0.006)	0.002(0.005)	0.001(0.005)	−0.006(0.005)	−0.000(0.006)
ECT_{t-1}	−0.376(0.081)***	−0.165(0.044)***	−0.176(0.041)***	−0.199(0.037)***	−0.130(0.030)***	−0.153(0.033)***	−0.199(0.043)***	−0.149(0.034)***
ΔY_{t-1}	−0.100(0.079)	0.234(0.070)***	−0.010(0.074)	0.351(0.061)***	0.250(0.070)***	0.393(0.065)***	0.372(0.073)***	0.304(0.067)***
ΔY_{t-2}	0.019(0.471)	−0.062(0.070)						
ΔY_{t-3}	−0.129(0.040)***	−0.161(0.068)**						
$\Delta Poil_t$	1.055(0.041)***	0.385(0.067)***	0.818(0.086)***	0.313(0.055)***	0.081(0.049)*	0.161(0.047)***	0.265(0.050)***	0.297(0.055)***
$\Delta Poil_{t-1}$	0.264(0.083)***	0.319(0.074)***	0.400(0.100)***	0.282(0.062)***		0.142(0.051)***	0.093(0.05)*	0.189(0.060)***
Residual diagnostic tests								
Q(1)	0.001[0.938]	0.370[0.543]	0.031[0.860]	0.077 [0.543]	0.023[0.880]	0.471[0.493]	0.600[0.439]	0.131[0.718]
Q(4)	2.180 [0.703]	3.216 [0.522]	0.973[0.914]	0.228[0.994]	3.301[0.509]	4.865[0.301]	1.868[0.760]	3.052[0.549]
ARCH(1)	0.021 [0.885]	0.334 [0.564]	1.116[0.291]	0.029[0.866]	1.077[0.299]	0.599[0.439]	13.564[0.000]	0.258[0.611]
ARCH(4)	1.598 [0.809]	0.723 [0.949]	4.715[0.318]	1.599[0.809]	1.202[0.878]	0.895[0.925]	22.203[0.000]	4.439[0.816]

Notes: *, ** and ***, denote rejection of the null hypothesis of no cointegration at 10%, 5% and 1% significance level, respectively. Figures in parenthesis are standard errors. Q(i) is Ljung and Box's (1979) Q statistic against residual autocorrelation of order i and ARCH (j) is Engle's (1982) LM test against heteroscedasticity of order j. P-values of these tests are shown in square brackets

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7 Ranking of Natural Gas Transmission Projects at the Southeastern Corridor: A Multi-Criteria Approach on the Countries of the Region

Mehmet Baha Karan, Aydın Ulucan, and Arif Özden

Abstract

The southern energy corridor of Europe has been the subject of the main political developments and investment projects over the last decade. While Europe is focusing on energy needs and security, the energy-producing countries want to increase economic benefits by increasing their strategic importance. Turkey, which is placed between them, has a chance to become an energy terminal. In this study, Turkey's available and potential gas transmission projects, including pipelines and LNG, are ranked by using a multi-criteria decision-making technique, namely ELECTRE. The method, which uses quantitative and qualitative variables such as investment cost, geopolitics, country risk, and trade volume, reveals that the Israel-Turkey offshore project is the most suitable one for securing natural gas demand of Europe. The same methodology also implies that the Israel-Turkey offshore project is the best also for Israel. Lastly, the sensitivity analysis, which is applied using parameters of different scenarios to reflect the uncertainties in the decision-making process shows that this project is a priority for both countries as the interests of the two countries overlap. Moreover, our work has also indicated that scenarios that would make the second priority project of the countries are not realistic.

Keywords

Southern corridor · Natural gas · Pipeline projects · Multi-criteria decision making

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7.1 Introduction

The Southern energy corridor project is one of the most controversial issues in the European Union (EU). The chaotic political situation in the Middle East, new gas field discoveries in the Eastern Mediterranean, and the ambitions of Russia to control the energy market share in Europe, could be counted as some of the most controversial themes Firstly, Europe will create a new route to supply natural gas from the gas-rich Caspian Sea basin without bypassing already existing Gazprom routes. Compensating the declining gas production of Europe in the long run with diversified sources is another one. Moreover, it will serve to stabilize the volatile region of the South Caucasus by anchoring Azerbaijan to the Euro-Atlantic community (Koranyi 2017). With the discoveries in the Eastern Mediterranean, the project has become more energetic and versatile to fulfill the goals of EU. However, the developments after 2011 have placed the region on the heart of world geopolitics, and this has created a series of conflicts and regional wars; justifying the paradox of plenty (Ross 2015). The annexation of Crimea by Russia, the Syrian Civil war, Russian-Turkey conflict, the coup attempt in Turkey, the rising PKK (Kurdistan Workers' Party) and ISIS (Islamic State of Iraq and Syria) terror, Turkey-Israel dispute, and the ISIS-NATO (the North Atlantic Treaty Organization) war have been some of the main highlights in the region during this short period.

Meanwhile, numerous pipeline projects have been planned and developed in the last decade to transport the gas of the region to Europe. However, most of them such as Nabucco[1] project, SEEP,[2] and the West Nabucco projects have failed sharing the same fate. TANAP[3] and TAP[4] projects have been the only ongoing projects at present. After the discoveries in the Eastern Mediterranean, the projects such as the Israel-Turkey Pipeline, and the Israel-Cyprus-Greece Pipeline have been suggested for development among others. Considering the capacity and political risk for Europe, Eastern Mediterranean projects could be a preferable route for the EU. However, the conflict between Turkey and Israel, which was solved at the summer of 2016, has stalled the negotiations in the last years. Meanwhile, Gazprom proposed a challenging project, which was called the Turkish Stream, to replace the South Stream, with the aim of connecting the North Black Sea region to Bulgaria. However, the Turkish Stream project included a pipeline from Russia directly to Turkey, and then to Europe. Also, the deal was not welcomed by the EU, which has been increasingly concerned about over-dependence on Russian gas (Pourzitakis 2015). Russia has the structural power to influence the energy policies of the European Union and its member states (Godzimirski et al. 2015). By developing

[1]The Nabucco pipeline was a suggested natural gas pipeline from the Turkishborder to Austria.

[2]South East Europe Pipeline (SEEP) which was a planned natural gas pipeline from eastern Turkey to Baumgarten an der March in Austria.

[3]The Trans-Anatolian Natural Gas Pipeline is a natural gas pipeline from Azerbaijan through Turkey to Europe.

[4]The Trans Adriatic Pipeline (TAP) which is an extension of TANAP.

new projects, such as south stream and Turkish stream, Russia tries to stay in the game to keep their share in the EU market. Although the plan has paused due to the Turkey-Russia conflict, the project discussions restarted with more enthusiasm after the summer of 2016 when the tense relations between the two countries thawed.

Turkey is the key country in most of the possible southern corridor projects with numerous project proposals. Although Turkey has no gas reserves, the geographical location of the country makes it indispensable in all strategic plans. The previous experiences and unsuccessful projects indicate that developing a natural gas transmission project to Europe without the cooperation of Turkey would be not practical in the region. The other potential headliner country is Israel. The country has the richest reserves in the Eastern Mediterranean region and strong ties with the US (United States) and the western world. Although there have been many options to import their gas, such as pipelines, LNG terminals, and electricity exports, Israel has significant constraints which are related to political problems with neighbors, energy security issues, and geographical conditions. Other countries of the region like Iran and Iraq, have either limited options or stay away from the current developments due to political reasons.

Although project decision-makers and financiers normally focus on the cost of the projects, particularly in energy investments, the security risk, which is connected with political risk and business risk factors, has exceptional importance in project selection. Moreover, Winzer (2011) reveals that the confusion about energy security is also reflected in political actions. Business relations, political considerations and worries on energy security often send away the decision makers from the optimal cost projects. In this way, Russia is investing in the Turkish Stream to bypass Ukraine, which is located on the optimal route to Southern Europe.

Energy policy issues of the countries that originate from political geography and security concerns are multiple and multidimensional (Brenner 2016). The volatile political atmosphere and regional conflicts of the Middle East enforce the countries in the region to seek more energy secure investments, following the EU, which places energy security at the top of her agenda. From the perspective of energy-poor countries like Turkey, the meaning of energy security is "the uninterrupted availability of energy sources at an affordable price".[5] However, energy-exporting countries like Israel focus on maintaining the security of demand for their exports, which after all generate the overwhelming share of their government revenues (Yergin 2006). Moreover, policymakers generally equate the access of energy security with energy independence (Cohen et al. 2011).

The studies on energy security of the Middle East and Southern Corridor are increasingly seen in international studies, as more conflicts in the region arise. Fattouh (2007) claims that the energy market of the Middle East has a high level of political risk. The market is full of contradictions and divisions; it will probably continue to be exposed to shocks and disruptions. Abdelal and Tarontsi (2013) indicate that the projects of the southern corridor are advancing slowly not only

[5] https://www.iea.org/topics/energysecurity/

because of the political problems but also technological and commercial challenges. The southern corridor includes only a part of the overall plans for Europe's energy security, but the developments in the region will, to some extent, affect the energy security of the European Union. Moreover, the recent developments prove that the security risk of the Southern Corridor is the most critical component of project selection.

In this context, decision makers of energy projects have two options; the first is that the technicians calculate the feasibility of alternative projects by first focusing on the cost-revenue base and then presenting the eligible projects to the final decision makers. They can consider all aspects of the project including the security risk, and choose the best one, based on intuition. The second option is merging and analyzing all perspectives, including the energy security issues in decision-making. These methodologies, which has been developing since the 1970s, can establish a relationship between all alternatives and factors that affect the decision, then can calibrate alternative projects clearly and consistently (Taha 2013). Eventually, energy security becomes one of the factors that affect the decision process. In this way, the financial gap between cost-effective projects and the most secure investment can be reduced and give more reasonable information to the decision makers and the public. Multi-Criteria Decision Models (MCDM) have been widely used in not only technical papers but also in economics, social and environmental projects. In energy investments like in other areas, there could be different projects and different hypothetical solutions. The "best" choice resulting from applying MCDM methods would be the best-discussed solution, and not explicitly the optimum (Taha 2013). Detailed information will be given about MCDM at the methodology section of this paper.

The aim of this study is primarily to evaluate Turkey's options to supply natural gas from different countries using MCDM. Then the best choice found for Turkey will be assessed regarding the selected country involvement. Many studies in the literature use similar methodology (For example, Georgopoulou et al. 1997; Diakaki et al. 2010). However, this study separates itself by employing multi-criteria analysis for two countries with a comparison of results.

The study has eight parts. After the introduction section, the natural gas vision of Turkey will be explained. Then the literature part comes. The methodology and model application processes are respectively presented in the fourth and fifth sections. Evaluation criteria and data are explained in the sixth section. The scenario analysis for Turkey and Israel are given in the seventh and eighth sections. The paper ends with the conclusion part. Since various concepts are used in this study, abbreviations of terms are given both in the text and in "Abbreviation".

7.2 Natural Gas Vision of Turkey and Alternative Projects

There is no doubt that the natural gas vision of Turkey is determined by its geographical location, which makes the country a bridge between the continents for international trade. Connecting the rich natural gas reserves located at the Middle East, the Caucasus, Russia and Eastern Mediterranean, to the European markets may make Turkey, the Natural Gas Trade Center of the Eastern European Corridor

(Karan et al. 2014). Becoming a significant gas importer with a growing economy and population is also strengthening the position of Turkey. The volatile political environment and regional wars and crises in the last decades obligate Turkey to pursue a multiple and multi-dimensional energy policy, as Brenner (2016) argues, to fulfill her needs and reach her ultimate goals. Moreover, the targets highlight the possibility of energy supply diversification for the European Union (EU) and Turkey. The project options of Turkey include not only pipeline projects, but also LNG terminals. Recently, Turkey started to develop storage facilities and LNG options. In the coming years a total of 155 million cubic meters of daily withdrawal capacity is expected. Furthermore, Turkey also focuses on LNG operation within this context. Turkey's first Floating LNG Terminal (FSRU) was put into operation by the private sector in Aliağa in late 2016.

The potential projects of Turkey for the period of 2018–2025 are given below. Although most of the projects are officially signed, negotiations continue. However, there has not been an official agreement on the Israel project yet (Fig. 7.1). The projects are:

- Azerbaijan-Turkey (TANAP+TAP) Pipeline: TANAP (Trans-Anatolian Pipeline) and TAP (Trans-Adriatic Pipeline) are ongoing projects and chosen by the Shah Deniz consortium for carrying Azerbaijani gas to both Turkey and EU (Greece and Italy). Project length is 1832 km, and currently, 64.8% of the project is complete, and the total cost of the project will be approx. 9 billion USD. Construction works continue in the TAP project, and the first gas flow is expected to take place in 2020. The TAP project has a total of 878 km of pipeline. This is the only project that provides Turkey an opportunity to re-export natural gas.
- Qatar LNG Project: Turkey tries to focus on LNG and storage solutions to avoid daily shortages due to peak demand-related winter conditions. Turkey may sign a long-term sales and purchase agreement with Qatar to provide natural gas, or Turkey could focus on Qatar's spot cargoes. When we look at the current LNG terminals in Turkey, three of them are overbooked in the winter time. Therefore, Turkey should focus on a new terminal that can be a FSRU. The approximate cost of the FSRU and related infrastructure is 500 million USD, and the total capacity of the ship is 6 bcm/a.[6]
- Russia-Turkey (Turk Stream) Pipeline: The pipeline project, which connects north and south Black sea shores, was originally designed and named as South Stream. However, its name and the route changed due to EU policy, which obstructs the plans of Gazprom. It was planned as a mainly offshore pipeline of approximately 900 km, and it will be continued onshore to approximately 190 km. Turkey and Russia signed an intergovernmental agreement on the pipeline at the end of 2016. The approximate cost of the project is 12–14 billion USD. However, the EU looks reluctant to engage in this project due to the overdependence on Russian gas.

[6] http://www.lngworldnews.com/report-turkey-agrees-lng-import-deal-with-qatar/

Fig. 7.1 Alternative Natural Pipeline Projects of Turkey

- Turkmenistan-Turkey Pipeline: Turkey and Turkmenistan signed sales and purchase agreement for 15.6 bcm/a natural gas from Turkmenistan to Turkey in 1999. However, the project never eventuated. The proposed Trans-Caspian Pipeline (TCP) is aiming to bring Turkmen gas to Europe. The project has recently become a topic of intense debate. Despite the existing barriers to the implementation of the project, there have been positive shifts towards its construction. The collective engagement of the interested parties—Azerbaijan, Turkmenistan, Turkey and the EU—in overcoming the various barriers to the project's application, indicate a strong chance of success.[7] The cost of the project will change to 10–23 billion USD. If the project uses the TANAP project, the cost of the construction will be approximately 10 billion USD.
- Iran-Turkey Europe (ITE): This pipeline project aims to transport the Iranian- and Turkmenistan-originated natural gas via Turkey to Europe. The agreement on the project, which started in August 2011, provides that Turkey can purchase gas from the pipeline when it needs gas. The length of the pipeline is approximately 5000 km, and the pipeline within the territories of Turkey is 1789 km. It is planned to have 35 billion cubic meters of gas to be transported to Europe annually. The cost of the project may reach 18 billion USD. However, Iran also uses the TANAP for bypassing the Turkey section. Afterward, the cost of the project will decrease to 10 billion USD.
- Iraq-Turkey Pipeline: This pipeline is in the planning phase and may give Turkey a new supply country and route. The length of the project will be approximately

[7] http://www.naturalgasworld.com/the-momentum-for-the-trans-caspian-pipeline-24590

900 km, and the cost will be 5 billion USD. The project seems risky due to the political climate and the Turk-Kurd relationship. However, the Kurdish region of Iraq also needs that project for revenue.

- Israel-Turkey Pipeline: Over the past decade, significant natural gas deposits have been found in the Levant Basin of the Eastern Mediterranean. Recent discoveries of natural gas offshore to Israel, Cyprus and Egypt give all the countries the opportunity to become energy exporter countries. However, the international community has been focusing on the Levant Basin, where mostly Israel (Partly Cyprus) has found a major opportunity to develop significant offshore gas resources. Israel or East Mediterranean gas now is a new opportunity to both the EU and Turkey for providing the gas securely and affordably. Currently, there are two alternative pipeline projects from Israel; The Israel-Turkey Offshore and Onshore projects. The costs of these projects are 2.5 and 1.5 billion USD, respectively. However, the projects have not only technical difficulties but also have some diplomatic barriers.[8] Unlike other options, there is not yet an official agreement on this project, and the Turkey route is not the only rational option for Israel.

7.3 Literature Review

The Multi Criteria Decision Analysis (MCDA) deals with conflicting decision problems under the evaluation of several criteria. Today, energy and environment related issues are one of the most popular application areas of MCDA (Zhou et al. 2008). There is a number of MCDM literature on energy sector from energy planning and assessment to selection and allocation of projects. A variety of MCDA methods exist in the literature and have been used in several studies of energy decision aid problems since the 1970s. For example, Corner and Kirkwood (1991), Pohekar and Ramachandran (2004), and Zhou et al. (2008) focused on the literature reviews on MCDA to present studies on energy issues for varying time periods. Mardani et al. (2015) also mention that energy, environment, and sustainability topics are ranked as the first areas that have applied MCDM techniques and approaches in their recent literature focus on MCDA techniques and application.

Although, MCDA-based approaches have frequently been used in energy-related decisions in the literature, there exist limited studies on the evaluation of the transmission of natural gas using MCDA approaches. Table 7.1 shows the MCDA/Natural Gas Transmission project selection studies and corresponding alternatives and criteria.

[8]The fields are offshore fields that lie down 2000 m deep and more than 100 km away from the coast of both country and these discoveries seem to increase regional conflicts, due to international maritime EEZ (An exclusive economic zone) borders between the coastal states in the region.

Table 7.1 MCDA/Natural gas transmission project selection studies and corresponding alternatives and criteria

Study	Alternatives	Criteria	Technique
Thomaidis and Mavrakis (2006)	• A: Initially planned route of the Nabucco • B: Current Nabucco route • C: 'Orient Express Pipeline.' • D: Turkey–Greece–Italy pipeline	• Project risk, • Project costs, • Intermediate markets with several sub-criteria	Analytical Hierarchy Process
Afgan et al. (2007, 2008)	• Yamal Route; • Nabucco Route; • West Balkan Route; • LNG Neum Route; • Gas by Wire Route	• Environment Indicator, • Natural Gas Cost • Transport Cost • Investment • Natural Gas Demand	ASPID—analysis, and synthesis of parameters under information def. Multi-criteria analysis
Gomes et al. (2009)	• Eight different options for the destination of the natural gas reserves recently discovered in the Mexilhão field	• Return vs. Risk Relationship • Social and environmental impact • Demand vs. National Supply Balance • Regulation (tax, HSSE, price, market) • Political Aspect • Alignment with Company Strategy • Technology available • Timing of the implementation of the option	TODIM method
Tavana et al. (2013)	• Northern (N), • Southern (S), • Eastern (E), • Western (W), • Southeastern (SE) routes.	• Economic • Political • Legal • Environmental • Geographical and Technological A total of 24 factors	PROMETHEE with GDSS
Androulaki and Psarras (2016)	27 route alternatives to Greece	• Production cost, • Relative transfer cost, • Reserves-to-production ratio, • Overall risk of corridor, • Total trade, • Total energy trade	UTA II, Extreme Ranking Analysis
Lazarevska and Mladenovska (2016)	• Existing pipeline • South Stream • Trans-Adriatic Pipeline (TAP); • Energy Community (EC) Gas Ring; • Liquid Natural Gas (LNG); • Gas storage.	• Economic factors • Environmental factors • Social factors • Technical factors A total of 16 factors	Analytical Hierarchy Process

Thomaidis and Mavrakis (2006) develop an analytic hierarchy process model for determining the most preferred route of the transcontinental gas pipeline that branches in SE Europe to transport Caspian gas further into the targeted markets of Europe. The study of Afgan et al. (2007, 2008) is focused on the evaluation of the potential routes for natural gas supply to the southeast and central European countries. They also develop a MCDA model for the assessment of supply options for southeast and central Europe.

Gomes et al. (2009) study on the problem of selecting the best option for the destination of natural gas in the Mexilhão field in Brazil using the TODIM method. Vaszi et al. (2010) analyze the new routes of natural gas transport and their effect on Slovakia. Tavana et al. (2013) evaluate alternative export routes in the Caspian Sea basin using Group Decision Support System (GDSS) and Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) model. The proposed system decomposes the route selection process into manageable steps. Stegen and Palovic (2014) develop a decision-making tool for supplying energy decisions. This tool has a four-dimensional model to help policymakers and managers identify suitable suppliers and prioritize the best courses of action for overcoming obstacles. Androulaki and Psarras (2016) evaluate 27 alternative natural gas supply corridors for Greece using the MCDM approach. Lazarevska and Mladenovska (2016) investigate potential routes for natural gas supply to Macedonia and examined relevant scenarios.

7.4 Methodology

The MCDA is concerned with structuring and solving decision and planning problems involving multiple criteria (Majumder 2015). The MCDA methods can be differentiated into multi-objective decision making (MODM) and multi-attribute decision-making (MADM) categories (Climaco 1997). The MODM is used for continuous decision space problems, like mathematical programming problems with multiple objective functions, but MADM evaluates decision alternatives against a set of criteria. It is devoted to problems with discrete decision spaces, which have predetermined decision alternatives (Triantaphyllou et al. 1998). The MADM encloses variant techniques such as the Analytic hierarchy process (AHP), the Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE), Elimination Et Choix Traduisant la Rlalité (Elimination and Choice Expressing Reality or more commonly—ELECTRE), and the Multi-attribute utility theory (MAUT) (San Cristóbal 2011; Taha 2013).

The ELECTRE is a methodology of the MCDA to rank all of the alternatives of models by utilizing discrete criteria of quantitative and qualitative variables. The construction of outranking relations, which aims at comparing comprehensively each pair of actions, is the initial section of ELECTRE application. In the second stage, the recommendations obtained in the first phase are operated and evaluated carefully. The nature of the recommendation depends on the problem being addressed, i.e., choosing, ranking or sorting (Gavade 2014).

ELECTRE method, presented by Roy (1968), has various types of models used for choosing, ranking or sorting purposes. The ELECTRE I, ELECTRE IV and ELECTRE IS versions are developed for choosing among alternatives. The ELECTRE II, ELECTRE III, and ELECTRE IV versions are used for ranking purposes. Finally, the ELECTRE TRI version aims to sort alternatives (Figueira et al. 2005). The ELECTRE methods are commonly used in many environmental and energy issues, mainly in energy planning and project selection. Some examples of this kind of studies are the studies of Karagiannidis and Moussiopoulos (1997), and Beccali et al. (2003). In our study, we use ELECTRE III for computations in project ranking.

The ELECTRE III methodology can be divided into three general phases; setup, outranking and final ranking. During the setup phase, alternative set $A = (a, b, \ldots n)$ and a criteria set $G = (g_1, g_2, \ldots g_m)$ are determined. The criteria value of alternative a_i concerning criteria g_j. is denoted by $g_j(a_i)$ and also determined in this stage. The decision maker also determines thresholds associated with each criterion to be used in pairwise comparisons in this phase. In the ELECTRE III, there are three types of thresholds: preference $p_j(g_j(*))$, indifference $q_j(g_j(*))$ and veto thresholds $v_j(g_j(*))$. The last outcome of this stage is the importance of each criterion that gives the weight of the criteria.

During the outranking phase, all criteria of the problem are converted into pseudo-criteria to account for the fuzzy nature of the model using the thresholds determined in the previous stage. These threshold values produce outranking relations while making allowances for uncertainty in the data. In ELECTRE III the degree of outranking relation is measured by a credibility matrix. To do this the first concordance index $c(a, b)$ is computed with the following function for each pair (a, b) of alternatives according to each criteria.

$$c_j(a,b) = \begin{cases} 1 & if \quad g_j(a) \geq g_j(b) - q_j \\ 0 & if \quad g_j(a) \leq g_j(b) - p_j \\ \dfrac{g_j(a) - g_j(b) + p_j}{p_j - q_j} & otherwise \end{cases}$$

Then using the criteria weights, concordance indices are combined as cumulative concordance matrix.

$$C(a,b) = \frac{1}{W} \sum\nolimits_{j=1}^{n} w_j c_j(a,b) \ where \ \ W = \sum\nolimits_{j=1}^{n} w_{j.}$$

Then using the veto thresholds, the discordance matrix is computed using the following function:

$$d_j(a,b) = \begin{cases} 0 & if \quad g_j(a) \geq g_j(b) - p_j \\ 1 & if \quad g_j(a) \leq g_j(b) - v_j \\ \dfrac{g_j(b) - g_j(a) - p_j}{v_j - p_j} & otherwise \end{cases}$$

Using a cumulative concordance and discordance matrices the credibility matrix is constructed using the function below:

$$S(a,b) = \begin{cases} C(a,b) & if \quad d_j(a,b) \leq C(a,b), \forall j \\ C(a,b) \prod_{j \in J(a,b)} \dfrac{1 - d_j(a,b)}{1 - C(a,b)} & otherwise \end{cases}$$

J(a, b) set shows the criteria set for which $d_j(a, b) > C(a, b)$.

During the final phase of the ELECTRE III, the full ranking of alternatives is obtained using the ascending and descending distillation procedures (see Roy 1993 for details).

7.5 Model Application Process

The initial task of our application is to identify the major stakeholders and their preferences. Turkey's geostrategic position of being located at the gateway between the East and the West makes it a valuable player in Eurasian energy issues. As well as serving as an energy corridor, Turkey itself has been transformed into an energy-hungry country due to the increasing urban population, restructuring of the settlement areas and emerging industrialization (Atıcı et al. 2015). Therefore, Turkey is selected as the main stakeholder of our study. We test our hypotheses by applying ELECTRE methodology for Turkey at the first step. This test will show us the country which is the best choice for Turkey to provide natural gas. In the second step, we apply the same procedure for the selected country to understand if the country choices coincide.

In our novel application, we develop and solve two distinct MCDA problems for two different stakeholders. We then, focus on the common alternatives of these two problems and obtain policy implications. We also test our models with various scenarios. Our main research question is the determination of the best route alternative for Turkey. For this reason, in the first model, we develop the research from the viewpoint of the user/transmission hub country. Similarly, a second model is established from the point of view of the gas producer country determined in the first model.

Our motivation for this study is to observe the ranking of gas routes from the viewpoint of main stakeholder (Turkey) and Table 7.2 shows the key features of the model we developed.

Table 7.2 Main natural gas projects of Turkey and model characteristics

	Model 1
Decision Maker (Stakeholder)	Turkey
Position	User, Hub Country
Objective	Ranking of Natural Gas Transmission Projects through Turkey
Alternatives	Russia Pipeline Azerbaijan (TANAP+TAP) Pipeline Turkmenistan Pipeline Iran Pipeline Iraq Pipeline Israel-Turkey Offshore Israel-Turkey Onshore Qatar LNG
Criteria	Cost, Capacity, Trade, Country Risk, Business Climate Rating

7.6 The Evaluation Criteria and Data

Ranking of natural gas transmission projects requires an evaluation of economic, technical, and geopolitical dimensions. These dimensions are defined using five criteria; investment cost of the project, capacity of the project, trade value between the stakeholders of the project, country risk of the stakeholders involved in the project and business climate risks of the stakeholders participating in the project. Most of these criteria have commonly been used in previous studies. Investment cost criteria are used by Afgan et al. (2007) and Thomaidis and Mavrakis (2006), while the capacity of the project is included in the model of Lazarevska and Mladenovska (2016) as a technical factor. Cost criteria gives not only information on the size of the project but also covers the cost of technical complexities including the length of the project and pipeline costs. Androulaki and Psarras (2016) have used intercountry trading volumes in its multi-criteria method. The high volume of trade may create opportunities for new business ventures between the countries, including gas trade. On the other hand, in almost all publications, country, and business risk factors are taken into account under various names Gomes et al. (2009) and Tavana et al. (2013). Country risk relates to the degree to which political and economic discomfort affect the investors doing business in a particular country and naturally influences the gas projects. The last criteria is Busines Climate, which is an atmosphere of a given country that is appropriate for the operation of the business; usually encloses tax issues, attitudes of government toward business, and availability. Operational costs are not modeled in this study since these expenses are considered to be a certain percentage of the total investment cost in pipeline feasibility studies.[9,10] Also, the environmental and sociological effects of some studies have not been taken into consideration because the characteristics of all projects are more or less similar. In this study, the contribution of each project to the ultimate goal of Turkey being the energy terminal was not considered. The reason for this is the ambiguity in project works. The criteria of the study are given below:

- Cost and Capacity: The data on cost and capacity of pipelines are obtained from various sources[11] and experts from the Botas Pipeline Company of Turkey. The information, obtained from different sources, has been evaluated by Botas experts to attempt to reach the average costs according to the capacities of the projects.[12] Since there is no data on the Iraq pipeline investment cost, it is estimated to be 5 billion USD, assuming that it will be about half of the TANAP pipeline
- Trade: For the trade criteria we use the formula developed by Androulaki and Psarras (2016). For each alternative, we examine the trade values of countries involved. The formula shown below uses the trading interactions for the corresponding countries (x and y denote two different countries).

$$Trade\_index = \frac{E_{x \to y} + E_{y \to x}}{E_{x \to world} + E_{y \to world}}$$

- Country Risk: Country risk values are taken from coface.com (coface.com 2017). Coface is a significant French credit issuer company. Their analyses use an eight-level ranking. In ascending order of risk, these are A1, A2, A3, A4, B, C, D and E. The scores indicate a country's potential influence on business financial commitments. In the analysis, we convert rankings into 1–8 scale such that A1 equals 1 and E equal 8.
- Business Climate Rating: Business Climate Rating values are also taken from coface.com (coface.com 2017). Their analyses use an eight-level ranking. In ascending order of risk, these are: A1, A2, A3, A4, B, C, D and E. Scores indicate a country's potential influence on business financial commitments.

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[9] https://hub.globalccsinstitute.com/publications/co2-liquid-logistics-shipping-concept-llsc-overall-supply-chain-optimization/101-cost

[10] http://onlineresearchjournals.com/ajbe/art/63.pdf

[11] http://www.zerohedge.com/news/2016-10-10/turkey-and-russia-sign-strategic-turkish-stream-gas-pipeline-deal, http://www.ogj.com/articles/print/volume-113/issue-, 2/transportation/turkmenistan-positions-itself-as-eurasian-natural-gas-power.html, http://www.globes.co.il/en/article-gas-execs-see-israel-turkey-gas-deal-by-2017-1001135479, http://pdf.usaid.gov/pdf_docs/PA00KWB5.pdf

[12] One of the authors of the paper is pipeline expert at Botaş

Using the criteria weights and model parameters (Table 7.3), we conduct an ELECTRE III analysis to rank the decision alternatives for the models. The analysis of Model 1 provides us a ranking of alternative gas routes for Turkey.

The parameters of ELECTRE for the model are given in Table 7.4. The table lists the indifference, preference, veto thresholds, criteria types and criteria weights. For instance, for the capacity criteria, indifference value of 1 bcm means alternatives with capacity difference less than 1 bcm are assumed as indifferent. Similarly, preference value of 3 bcm means if an alternative A has the capacity value 3 bcm or more than alternative B then alternative A is preferred to alternative B. The values between 1 and 3 represent partial preference. Finally, veto threshold value of 10 means if an alternative A has the capacity value 10 bcm or more than alternative B then there is strong evidence that alternative A is better than B overall. Criteria type min (minimum) means lower values are better; max (maximum) means higher values are better. Finally we have employed three scenarios of criteria as seen Table 7.4; equally weighted, investment cost base and country risk base to investigate the effect of different criteria on the rank of the projects.

Table 7.3 Data for the Model 1

		Abbrev.	Cost bn $	Capacity bcm	Trade	Country risk	Business climate rating
MODEL 1	Russia	Rus	12.0	17.0	0.032	6	6
	Azerbaijan (TANAP +TAP)	Azer	9.0	17.0	0.011	6	6
	Turkmenistan	Turkmen	10.0	8.5	0.016	7	7
	Iran	Iran	15.0	3.0	0.007	8	6
	Iraq	Iraq	5.0	1.8	0.046	8	7
	Israel-Turkey Offshore	I-TOff	2.5	17.0	0.020	3	2
	Israel-Turkey Onshore	I-TOn	1.5	17.0	0.020	7	7
	Qatar LNG	QLNG	0.5	6.0	0.007	3	3

Table 7.4 Parameters of ELECTRE for models

	Cost bn $	Capacity bcm	Trade	Country risk	Business climate rating
Indifference Threshold (q)	1	1	0.005	0	0
Preference Threshold (p)	3	3	0.010	1	1
Veto Threshold (v)	7	10	0.040	3.5	3.5
Criteria Type (Min/Max)	Min	Max	Max	Min	Min
Equal weight Scenario (Base scenario) (w)	20%	20%	20%	20%	20%
Investment Based Scenario (w)	60%	10%	10%	10%	10%
Political Rating Based Scenario (w)	10%	10%	10%	60%	10%

7.7 Scenario Analysis for Turkey

The most critical stage of this model concerns the weights to be given to the criteria. Since it is not known which criteria will be given more importance by the decision-makers, various scenarios have been implemented. In the first phase, we assigned equal weights to the criteria to observe the rank of the project for Turkey without any prejudice. Figure 7.2 shows the result of the model using final pre-orders regarding pairwise comparison values for the Model 1. As can be seen in the figure, the Israel-Turkey offshore project has a superiority to all other projects according to the model. The second best project is the Turk Pipeline project from Russia (Turk Stream). They are followed by Qatar LNG, Iraq and TANAP Projects. Turkmen and Iran projects share the last two lines.

In the second phase, we assume that from the viewpoint of investors, the weight of certain criteria is more important compared to others. These are the cost of investment and country risk. It is obvious that the size of the projects increases their importance and the European Union and regional countries may give priority to big projects to decrease their energy security problems and increase economic benefits. Moreover, as the projects grow, the strategic importance of the countries in the region may increase. On the other hand, regarding the decision makers, the country risk of their partner countries are particularly substantial in the Middle East (Fattouh 2007). Political problems may create problems in financing projects and bilateral relations.

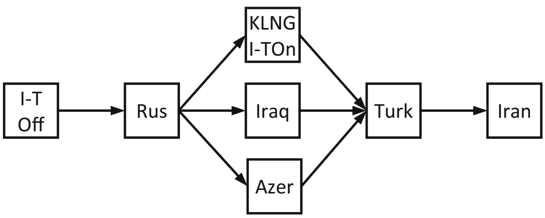
In the Investment Base Scenario, the weight of the investment cost criteria is increased to 60%, and the weight of each of the other criteria decreased to 10%. Similarly, country risk criteria are raised to 60% while others are decreased to 10%. All weights of the criteria are shown in Table 7.3.

Figure 7.3 shows the result of criteria weights in investment based scenario and visually represent the final pre-orders for Model 1. Israel-Turkey Offshore alternative again has the first rank for Turkey under this scenario.

Figure 7.4 shows the result of criteria weights in a country rating based scenario and visually represents final pre-orders for Model 1. The Israel-Turkey offshore alternative again has the first rank for Turkey with this scenario.

Although the result of Model 1 evidently indicates that Israel offshore option is the best for Turkey, it needs to investigate if this is the best rational way to Israel. If the interests of the two countries point to similar projects, we expect that it will be easier to negotiate between countries. Otherwise, new solutions will need to be investigated.

Fig. 7.2 Result of Model 1 (Decision of Turkey) under the equally weighted criteria scenario



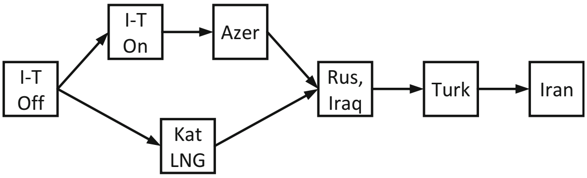


Fig. 7.3 Result of Model 1 (Decision of Turkey) under investment based scenario

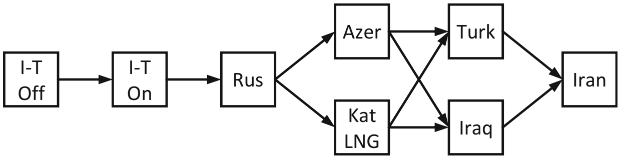


Fig. 7.4 Result of Model 1 (Decision of Turkey) under country risk-based scenario

7.8 Scenario Analysis for Israel

Since Israel's relationship with the neighbors of the Middle East is very volatile and can turn easily to conflict and confusion, the country prefers to work on alternative gas pipeline projects. Currently, Israel has eight options to export its gas reserves, and Turkey is included in two of them. The options that Israel has are given below, the first two pipelines are related with Turkey (Fig. 7.5).

- Israel Offshore Pipeline: The length of the project is about 500 km, and the expected cost of the offshore pipeline is 2.5 billion USD. Turkey may get 7 bcm/ gas from this pipeline.
- Israel Onshore Pipeline (Arab gas pipeline): The construction cost of the project will reach 1.5 billion USD.
- East Mediterranean Subsea: East-med Subsea pipeline proposes to export gas from the region to the EU (Greece). However, this pipeline has some problems due to physical constraints or probable maritime disputes. The approximate cost is 20 billion USD:
- Egypt Pipeline: It aims to convey 5 billion cubic meters of gas from Israel to Egypt.
- Jordan Pipeline: The first natural gas pipeline to from Israel-Jordan is scheduled to begin operating in 2017. The cost of the project is 1.8 billion USD, and its capacity is 1.8 bcm.
- Floating Liquefied Natural Gas (FLNG) Project: FLNG project is based on feed gas from Tamar and Dalit gas fields offshore Israel. The cost of the project is 11 billion USD, and current low LNG price is the main hurdle of the project.

Fig. 7.5 Alternative Natural Pipeline Projects of Israel

- LNG Export From Egypt: Israel wants to use of Egypt's LNG facilities as export terminals to reach markets like Europe and Asia. The capacity and cost of the project is respectively 4 bcm and 7 billion USD.
- LNG Export From Cyprus: The decision on building an onshore LNG plant in Cyprus to develop its offshore gas resources will depend on future gas discoveries. The expected cost of the project is 10 billion USD, and capacity is 6 bcm.

To rank the projects, we applied the similar methodology and the scenarios to Israel options using Model 2. This model divides the ranking of alternative gas supply routes for Israel gas reserves from the viewpoint of Israel. Tables 7.5 and 7.6 show the main characteristics and required data of the Model 2 to re-apply ELECTRE methodology for Israel. Model 1 data is also presented in Table 7.5 for comparative purposes.

In the initial phase, we followed previous steps under the equal weights scenario to observe the rank of the project for Israel without any prejudice. The result indicates that under equal weighting assumption, FLNG is the second best project while the first one is Israel-Turkey Offshore pipeline as in the previous analysis and the interests of the two countries coincide. For both stakeholders under the different alternatives, Israel-Turkey Offshore route is the major one. The third line shares Cyprus LNG and Jordan pipeline projects. Israel-Turkey Onshore takes fourth place. Other projects are respectively Egypt LNG, East Med, and Egypt Pipeline projects. Figure 7.6 shows the result of the model using final pre-orders in terms pairwise comparison values for the Model 2.

Figure 7.7 shows the result of criteria weights in the investment based scenario and visually represents the final pre-orders for Model 2. Israel-Turkey Offshore alternative again has the first rank for both models under this scenario. This result

Table 7.5 Main natural gas projects of Israel and model characteristics

	Model 2	Previous model (Model 1)
Decision Maker (Stakeholder)	Israel	Turkey
Position	Producer	User, Hub Country
Objective	Ranking of the Eastern Mediterranean Gas Route Alternatives	Ranking of Natural Gas Transmission Projects through Turkey
Alternatives	Israel-Turkey Offshore Israel-Turkey Onshore East Med Subsea Egypt Pipeline Jordan Pipeline LNG (Egypt) LNG (Cyprus) FLNG	Russia Pipeline Azerbaijan (TANAP+TAP) Pipeline Turkmenistan Pipeline Iran Pipeline Iraq Pipeline Israel-Turkey Offshore Israel-Turkey Onshore Qatar LNG
Common alternatives	Israel-Turkey Offshore Israel-Turkey Onshore	
Criteria	Cost, Capacity, Trade, Country Risk, Business Climate Rating	Cost, Capacity, Trade, Country Risk, Business Climate Rating

Table 7.6 Data for the Model 2

		Abbrev.	Cost bn $	Capacity bcm	Trade	Country risk	Business climate rating
Model 2	Israel-Turkey offshore	I-TOff	2.5	17.0	0.024	5	4
	Israel-Turkey onshore	I-TOn	1.5	17.0	0.024	7	7
	East Med Subsea	EstMed	20.0	8.5	0.013	6	3
	Egypt	Egy	0.9	3.0	0.002	6	5
	Jordan	Jor	1.8	1.8	0.006	5	4
	LNG export from Egypt	EgyLNG	4.0	7.0	0.002	6	5
	LNG export from Cyprus	CypLNG	10.0	6.0	0.019	6	3
	FLNG	FLNG	11.0	5.0	0.010	3	2

reveals that the Turkish offshore project is in the first place even when given to the size of the project.

Figure 7.8 presents that the result of criteria weights in country rating based scenario and visually represent final pre-orders for Model 2. Israel-Turkey Offshore alternative again has the first rank, and it proves that even if the country's risk weights are significant, the Turk-Israel option does not lose its importance.

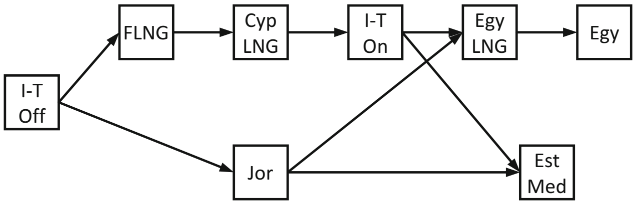


Fig. 7.6 Result of Model 2 (Decision of Israel) under the equally weighted criteria scenario

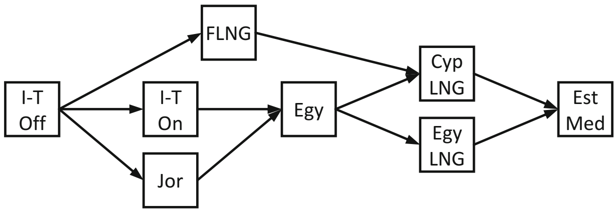


Fig. 7.7 Result of Model 2 (Decision of Israel) under investment base scenario

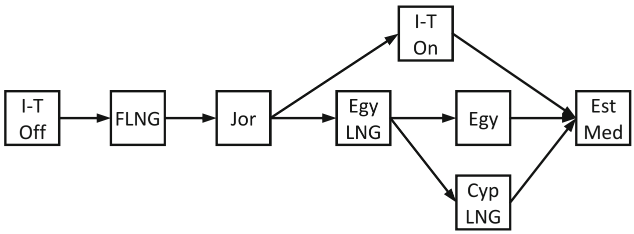


Fig. 7.8 Result of Model 2 (Decision of Israel) under country risk-based scenario

7.9 The Second Best Alternative Analysis

Another critical question of the research is that, under which conditions Israel-Turkey Offshore project loses its superiority where the second best project thus goes ahead. Two more scenarios have been developed by changing the weights to examine how the second best alternative could be the first best alternative. In this way, under what conditions can we see that the second scenario may be more attractive for the investor.

The second best option in the Turkish model was the Turk Stream from Russia. To improve this option, new scenarios have been developed. As a result of several weight combination, scenario runs we found that the Russia pipeline has the first rank only when we assign high weights to just two criteria; these are capacity and trade index. When we assign any weight to remain criteria, Israel-Turkey pipeline option always has the first rank. Therefore we can conclude that from the viewpoint

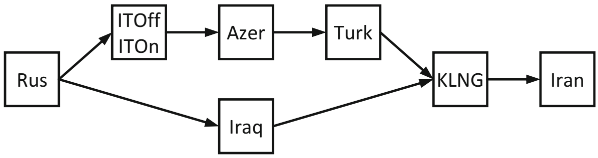


Fig. 7.9 Result of Model 1 (Decision of Turkey) under capacity and trade index scenario

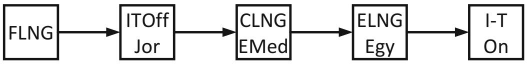


Fig. 7.10 Result of Model 2 (Decision of Israel) under country risk and business climate risk-based scenario

of Turkey, Israel-Turkey offshore pipeline option has the first rank in almost all of the criteria weight combinations.

Figure 7.9 shows the visual representation of final preorders with {0,00; 0,50; 0,50; 0,00; 0,00} criteria weight combination (capacity and trade index 50% each).

In the Israel model, the FLNG option was the second choice, and it has been researched to show under which conditions this option can be the first rank. As a result of several weight combination scenario employed we find that FLNG has the first rank only if we assign high weights to just two criteria; country risk and business climate risk. When we assign any weight to remain criteria, the Israel-Turkey pipeline option always has the first rank. Therefore we can conclude that from the viewpoint of Israel, the Israel-Turkey offshore pipeline option has the first rank in almost all of the criteria weight combinations.

Figure 7.10 shows the visually representation of final preorders with {0,00; 0,00; 0,00, 0,50; 0,50} criteria weight combination (country risk and business climate risk 50% each).

7.10 Conclusion

The southern gas corridor project of Europe lies within the politically and geographical complex region of the world. Religious wars and conflicting interests between the regional countries have delayed the investments on the planned natural gas projects. The developments in the region underline that energy security is as important as the economic benefits of the projects. Turkey is the most important country in the region regarding its geography since pipelines will pass through it at the lowest cost. For this reason, Turkey has been placed in the center of this work.

In our work, we used a multi-criteria decision-making model called ELECTRE and applied our model according to five criteria such as investment cost, capacity, trade, country risk and business climate risk. Since it is not known which criteria will be given more importance by decision-makers, the model was made under three different scenarios in the first phase. These are equally weighted, investment and country risk-based scenarios. The results indicate that the Israel-Turkey Offshore project is the most suitable one for Turkey under all scenarios. We follow the similar methodology for Israel to understand if the interests of two countries coincide and the outcome supported the findings for the Turkish model. In the second phase, it is investigated that under which conditions the second best project could replace the Israel-Turkey Offshore project. The result indicates that if Turkey considers only pipeline capacity and trade index criteria, skipping the other criteria, Turk Stream which comes from Russia will be placed in the first row. From the view of Israel, The FLNG project will rise to the first rank only the country risks and the business climate risk are weighted.

The results reveal that for Turkey, other options apart from Israel-Turkey Offshore option are not rational for the first rank. Deciding to give any weight to the country's risk can create problems in the long run. The fact that Turkey imports more than 50% of the natural gas consumption from Russia currently. Turkey would depend on Russia much more by a new Russian project, and this may push the country to a weaker position regarding energy security.

If the importance of the country/business risks are increased from the Israeli perspective, and the investment cost and capacity are not taken into consideration, the option of Turkey weakens. Given the unstable relations between the two countries in recent years, this can partly be understood for Israel. However, the fact that the FLNG project that is a lower-capacity with a higher-cost will prevent big players of international energy market from investing. Moreover, the conditions of LNG market, which is extremely competitive in recent years, is another obstacle. For this reason, Israel-Turkey Offshore is the most rational choice for Israel. The recent improvement in the relationship between the two countries already supports this view.

In fact, the Israel-Turkey Offshore project has the potential to provide significant benefits to both countries not only economically, but also geostrategically. It will make it easier for Israel to reach the EU market in low cost, and for Turkey to reach its energy terminal target. Beyond these, both countries will help diversify natural gas trade and reduce their energy security risks.

Moreover, the most significant contribution of this study is the evaluation of gas projects by using a multi-criteria method called ELECTRE. This methodology put in order all of the alternatives to models by employing discrete criteria of quantitative and qualitative factors. The literature review indicates that there is a limited number of studies on natural gas projects. The novelty of our approach is to apply ELECTRE for two countries which have complementary abilities with a comparability of results.

Future research may include more technical criteria about the projects, such as length of the pipelines and the transport cost. We assume that the cost of the project partly covers this handicap because investment costs increase as the technical difficulties in energy projects increase. Mostly these costs are assumed as a percentage of total investment cost. Environmental factors have been neglected in this study. Future studies could use models that will take these additional factors into consideration and this may provide interesting results.

Abbreviations

AHP	Analytic hierarchy process
ASPID	Archive of Spectral, Photometric and Interferometric Data
EEZ	Exclusive Economic Zone
ELECTRE	The Elimination and Choice Translating Reality
EU	European Union
FSRU	Floating LNG Terminal
GDSS	Group Decision Support System
ISIS	Islamic State of Iraq and Syria
ITE	Iran-Turkey Europe pipeline
LNG	Liquefied Natural Gas
MADM	Multi-attribute decision-making
MAUT	Multi-attribute utility theory
MCDA	Multi-Criteria Decision Analysis
MCDM	Multi-Criteria Decision Models
MODM	Multi-objective decision making
Nabucco	The Nabucco Pipeline is a natural gas pipeline that is planned to be built from Erzurum, Turkey to Austria (through Bulgaria, Romania and Hungary)
NATO	North Atlantic Treaty Organization
PKK	Kurdistan Workers' Party
PROMETHEE	Preference Ranking Organization Method for Enrichment Evaluation
SEEP	South East Europe Pipeline
TANAP	The Trans-Anatolian Natural Gas Pipeline is a natural gas pipeline from Azerbaijan through Turkey to Europe
TAP	The Trans Adriatic Pipeline
TCP	Trans-Caspian Pipeline
US	United States

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The Relationship Between Foreign Direct Investment and CO_2 Emissions Across a Panel of Countries

8

N. Yaşar and M. E. Telatar

Abstract

This paper analyses the relationship between foreign direct investment inflows and pollution emissions for 139 countries during the period of 1970–2015 and the countries are classified into four groups regarding to the World Bank income ranking. The main motivation of this study is to analyse, whether the causal relationship differs between different income groups. For this purpose, panel ARDL (Auto Regressive Distributed Lag) boundary approach and Granger causality test are used. The results of the study indicate that the causal relationship between FDI (Foreign Direct Investment) and CO_2 emissions differs depending on which income group country belongs to. We conclude that, while there is not statistically significant short-run causality relationship running from FDI to CO_2 emission for high income, upper middle income and low income group countries, the pollution haven hypothesis is supported for lower middle income group countries.

Keywords

Foreign direct investment inflows · Environmental pollution · CO_2 emission · Panel unit root · ARDL boundary approach · Panel causality

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8.1 Introduction

The relationship between foreign direct investment, growth and energy consumption has been investigated extensively in the economic literature. Recently, focuses of the researchers have been moved towards the use of renewable sources in the process rather than the use of non-renewables for example, e.g. fossil fuels. It is well documented that renewable sources have several advantages over fossil resources. It is clear that using renewable sources significantly reduce carbon dioxide emissions. Meanwhile, both developing and developed countries are showing great interest to use clean energy in production process by signing some international protocols. Kyoto Protocol in 1997 is a good example.

Although there is a huge literature on the subject, empirical studies on the relationship between FDI and level of environmental pollution have not found a conclusive evidence about the impact of FDI on environmental quality. According to the mainstream literature, actually there are two opposite hypothesises defining the effect of the FDI on environmental pollution indicators; *pollution haven hypothesis* asserts that there is a positive correlation between the FDI and environmental pollution indicators. Since stricter environmental regulations will increase the cost of the production process, to attract more multinational financial capital and to create lower cost of production possibilities host country will wave from high environmental standards regulations and taxes leading to increasing level of environmental pollution. Actually pollution haven hypothesis based on classical trade perspective of *comparative advantage* which assumes that environment is one of the production factor and more stringent regulations will increase the production cost (Shahbaz et al. 2015). In other words, if the environmental regulatory regime of the host country is non-restrictive, then an increasing in foreign direct investment inflows may have a downside effect on the environmental indicators of this country (Hoffmann et al. 2005; Wan-ping et al. 2008; Dean et al. 2009; Asghari 2013). Asghari (2013) argues that as a result of the pollution haven hypothesis, manufacturers relocate their production facilities to developing countries to get a benefit of lower production cost, which is known as *industrial flight hypothesis* in literature. Thus, carbon emissions have an increasing trend in developing countries whereas decline trend in countries with more tightened regulations, which is known as *carbon leakage effect* (Kuik and Gerlagh 2003).

However, according to the *pollution halo hypothesis* in applying a universal environmental standard, multinationals engaging in FDI will tend to spread its greener technology to their counterparts in the host country (Hoffmann et al. 2005: 311). In other words, along with the expansion of investment, advanced production methods and technologies will be transformed from the developed countries to the developing economies encouraging them to use environmentally friendly production technologies, which will cause to a decreasing effect on the pollution indicators of the host country (Wan-ping et al. 2008; Pao and Tsai 2011).

The pioneering study in the empirical literature on the subject is that of Grossman and Krueger (1991). Their purpose was to investigate the environmental impacts of a North American free trade agreement with 42 countries. Following Grossman and Krueger (1991), international trade and foreign investment policies may affect the environment pollution indicators in three different ways. First off all, according to the *scale effect,* liberal trade and investment policies will promote the scale of actual production, ceteris paribus which will lead to an increase in the environmental pollution level. Secondly, with expanding liberal trade process, the industrial composition of an economy will change due to country's gradual specialization in output in which it has a comparative advantage. So, ultimate impact of the *composition effect*[1] on the environment depends on the determinants of a country's comparative advantage. Finally, with liberalization of trade and foreign investment the environmental pollution will decrease for two reasons; since restrictions will release diffusion of modern and environmentally friendly technology will be easier and with increasing income demand for environmental quality will also increase. According to this study which indicates the first empirical evidence supporting Environmental Kuznets Curve (EKC), after a turning point income rising stimulated by liberal trade and investment regulations, leads to lower pollution level. According to Birdsall and Wheeler (1993), liberalization policies lead to import of the higher environmental standards which encourage employing of environmental friendly production technologies in the host countries. This study challenges the pollution haven hypothesis, arguing that liberal trade and foreign investment regulations in Latin America countries in 1960–1980 period are unrelated with pollution intensive industrial developments. Similar results were achieved by Cole (1999) asserting that economic growth process stimulates environmental quality which is not an automatic process, but a result of applied policies.

Although with the developments in applied literature advanced econometrics approaches were used to investigate this relationship, still there is not a consensus about the impact of FDI on pollution indicators. Since developed countries are generally capital-abundant and capital-intensive goods are typically pollution-intensive, according to the Factor Endowment approach developed countries will specialize in polluting goods. That is why Factor Endowment Hypothesis conflicts with Pollution Haven Hypothesis. Mukhopadhyay (2006) argues that, Thailand is an appropriate sample to test these two hypotheses and for this purpose input-output model was used in this study. According to the results obtained in this study, Factor Endowment Hypothesis is not supported, whereas Pollution Haven Hypothesis is supported in Thailand for 1980–2000 periods. Similar results were also obtained by Blanco et al. (2013), which analyse the causal relationship between FDI and CO_2 emissions in Thailand and Latin America respectively. Obtained results support the pollution haven hypothesis emphasising that FDI inflow industries leads to increasing in CO_2 emission indicators.

[1]Or *structure effect* as it indicated in Jian and Rencheng (2007).

As China is one of the countries with the highest carbon dioxide emission, Liang (2006), Di (2007) and Zhang (2011) investigate the relationship between financial developing and carbon emission for China using different econometric methodologies for different time periods. While Liang (2006) argues that local pollution decreases with the FDI inflow and the pollution halo hypothesis is supported, Di (2007) and Zhang (2011) indicate that financial development contribute to carbon emission indicators, thus pollution haven hypothesis is valid for China.

Since panel data estimation model bring forth more powerful results than time series estimation techniques, there are numerous empirical studies using panel data estimation methods. Hoffmann et al. (2005) investigates the causality relationship between FDI and CO_2 emission for the 112 country panel categorized into three income groups. Following the obtained results there is an unidirectional causality running from CO_2 emission to FDI for low-income countries, whereas there is an unidirectional causality from FDI to CO_2 emission for middle income country groups and finally, there is not any causality relationship between the variables for high-income country panel. Another study that categorized countries into different income groups is Shahbaz et al. (2015). Following the results of this study, the pollution haven hypothesis is supported for all country groups in the time period of 1975–2012. However, Cole et al. (2006) argues that the impact of FDI on environmental regulations related with government's degree of corruptibility for 13 OECD and 20 developing countries for the period 1982–1992. Obtained results indicate that FDI increases local environmental policy stringency for the lower degree of government corruptibility and thus FDI contributes the creation of a pollution haven. Asghari (2013) investigates whether the pollution halo or haven hypothesis is supported for MENA countries from 1980 to 2011 period. According to the obtained result investment inflow has week and statistically significant negative relationship with the carbon emission implying that the pollution halo hypothesis is supported for MENA countries in observed period.

In spite of the fact that it is a well-studied topic within the scope of large number of studies based on different countries, time periods, methods and variables, there is no single empirical evidence derived from these studies on the impact of FDI on environmental pollution level. This varietyin the results may be correlated with different model specifications, time periods, econometric approaches or selected variables.

This study examines the causal relationship between foreign direct investment inflows and carbon emission for a sample of 139 countries of different income level categories. The main motivation of this study is to find out whether the direction of causal relationship between FDI and CO_2 emissions level changes across different income group of countries. For this purpose, we used panel unit root tests to investigate stationary properties of the observed series. Unlike the previous studies, we estimated ARDL (Auto Regressive Distributed Lag) model to study whether FDI and emission series are co-integrated or not. Finally, we used panel VEC model to investigate significance of the short-run and long-run causal effects.

This study is organized in the following way. The second section discusses the empirical model specification and estimation techniques. The next section presents empirical results and the final section provides concluding remarks.

8.2 Econometric Methodology

As it is well known, the results obtained from the time series regression model which contains a unit root, may not represent the real relationship between variables and lead to the spurious regression problem. Therefore, in this study the Breitung (2000), Levin et al. (2002), Im et al. (2003), Maddala and Wu (1999), Choi (2001) methods are applied to analyse whether the FDI and CO_2 emissions series contain a unit root or stationary. Breitung (2000) and LLC (2002) tests require the homogeneity across the series, whereas IPS (2003), Choi (2001), Maddala and Wu (1999) tests allow for the heterogeneity in the dynamics of autoregressive coefficients.

On the other hand, if the series under consideration are co-integrated, the findings obtained from the regression analysis may imply the real relationship between the variables. There are two types of co-integration tests which are commonly used in econometrics for this purpose; Engle and Granger (1987) and Johansen (1988) and Johansen and Juselius (1990). Both techniques are applicable if only related series are stable at the level or have the same order of integration. However, ARDL proposed by Pesaran et al. (2001), can be applicable indifferent to the composition of the observed series, integrated order 0 or 1.

The ARDL modelling approach estimating as follows:

$$\Delta X_t = \propto_{20} + \sum_{i=1}^{m} \gamma_{2i} \Delta X_{t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta Y_{t-i} + \sigma_{2X} X_{t-1} + \sigma_{2Y} Y_{t-1} + \epsilon_{2t} \tag{8.1}$$

$$\Delta Y_t = \propto_{10} + \sum_{i=1}^{n} \beta_{1i} \Delta Y_{t-i} + \sum_{i=1}^{m} \gamma_{1i} \Delta X_{t-i} + \sigma_{1Y} Y_{t-1} + \sigma_{1X} X_{t-1} + \epsilon_{1t} \tag{8.2}$$

where, X is FDI inflow and Y implies CO_2 emission in this study.

After estimation of the above mentioned ARDL model, the null hypothesis, which implies that series are not co-integrated i.e., $H_0 : \sigma_{iX} = \sigma_{iY} = 0$ for $i = 1$, 2, should be tested. For this purpose rather using standard F-test, the upper (for I(1)) and lower (for I(0)) bounds statistics suggested by the Pesaran et al. (2001), are implemented. If calculated test statistics is over critical value, then the null hypothesis is rejected. Additionally, if obtained test statistics is below the lower bound value, it will imply a co-integration relationship among the series, whereas if this statistic run into the I (1) and I (0) bounds, indefinite results will be acquired.

According to the Engle and Granger (1987), if any observed series are co-integrated, then there is at least an unidirectional causal relationship between these series and vector error correction model (3) and (4) should be estimated to examine the dynamics of this causality.

$$\Delta X_t = \propto_{20} + \sum_{i=1}^{m} \gamma_{2i} \Delta X_{t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta Y_{t-i} + \delta_X EC_{t-1} + u_{2t} \tag{8.3}$$

$$\Delta Y_t = \propto_{10} + \sum_{i=1}^{n} \beta_{1i} \Delta Y_{t-i} + \sum_{i=1}^{m} \gamma_{1i} \Delta X_{t-i} + \delta_Y EC_{t-1} + u_{1t} \tag{8.4}$$

where the u_{1t} and u_{2t} are normally distributed error terms. The error correction term, EC_{t-1}, implies the adjustment of the long-run equilibrium, at which a dependent variable returns to equilibrium after a change in other variables. The F-statistics on the lagged dependent variables indicate the significance of the short-run effects, whereas the t-statistics on the coefficients of the lagged error correction terms indicate significance of the long-run causal effect (Telatar 2015).

8.3 Estimation and Test Results

This study analyses the relationship between FDI and CO_2 emission for 139 countries during the period of 1970–2015, applying panel data research methodology. The annual data used in this study are categorized into four groups; high, upper middle, lower middle, and low income, based upon the World Bank income classification and obtained from the World Bank's World Development Indicators. The CO_2 emission data is indicated in metric tons per capita, whereas FDI is (net inflows) % of GDP.

8.3.1 Panel Unit Root Analysis

Without taking the natural logarithms of the all series, panel unit root tests as Maddala and Wu (1999), Choi (2001), Breitung (2000), LLC (2002) and IPS (2003) were implemented to find out whether the series have a unit root or they are co-integrated. The obtained results are presented in Table 8.1.

As it can be seen from the table above, there is no single conclusion about the stationarity features of the series. According to the results of some unit root tests, FDI and CO2 emission series are integrated of order 0. However, some of the obtained results imply first-order stationary processes. Conflicting results obtained from the panel unit root tests, provide an inconclusive conclusion about the order of

Table 8.1 Panel unit root tests

Variables	LLC		IPS		ADF–Fisher		PP–Fisher		Breitung
	Intercept	Intercept +Trend	Intercept	Intercept + Trend	Intercept	Intercept + Trend	Intercept	Intercept + Trend	Intercept + Trend
High income country panel									
CO_2	−0.23	1.36	−0105	0.75	136,14*	126.63*	135,95*	187.74*	6.06
FDI	−12.41*	−14.39	−13.73*	−13.75*	413.57*	445.46*	408.70*	455.25*	−6.51*
Δ CO_2	−39.24*	−38.49*	−38.41*	−37.45*	1217.96*	1158.59*	1246.2*	1532.32*	−29.69*
Δ FDI	−53.95*	−49.78*	−50.72*	−48.44*	1456.71*	2276.85*	1460.6*	5120.02*	−23.52*
Upper middle income country panel									
CO_2	2.21	−0.83	1.79	−1.34	84.85	115.04*	137.49*	99,32*	0.09
FDI	−3.05*	−4.69*	−3.34*	−4.25*	116.17*	145.28	184.41*	226.26*	−6.38*
ΔCO_2	−14.82*	−14.06*	−19.85*	−15.65*	573.37*	472.08*	1012.8*	1245.16*	−9.88*
ΔFDI	−21.1*	−17.05*	−24.95*	−21.93*	699.761*	585.04*	1092.5*	3619.1*	−16.72*
Lower middle income country panel									
CO_2	3.62	−1.40	3.03	−0.74	94.69*	100.62*	336.45*	349.82*	5.30
FDI	−5.01*	−7.03*	−7.09*	−8.81*	192.86*	225.94*	192.50*	233.56*	−6.41*
ΔCO_2	−33.08*	−32.57*	−33.47*	−32,99*	880.73*	853.99*	917.14*	1045.98*	−11.58*
ΔFDI	−40.50*	−37.25*	−38.05*	−35.77*	944.713*	1165.67*	893.13*	3412.94*	−23.33*
Low income country panel									
CO2	0.94	1.98	2.34	2.13	24.16	16.63	22.30	34.58	2.93
FDI	−3.52*	−3.95*	−3.78*	4.02*	59.01*	62.31*	91.69*	99.63*	−4.02*
ΔCO2	−7.64*	−6.69*	−11.39*	−10.91*	186.193*	165.09*	380.59*	714.86*	−5.96*
ΔFDI	−14.51*	−13.79*	−14.66*	−13.42*	228.99*	190.57*	383.28*	1405.65*	−8.59*

*Indicates significance at the 5% level

Table 8.2 Co-integration tests

	High income country panel	Upper-middle income country panel	Lower-middle income country panel	Low income country panel
F-statistic				
$ARDL_{FDI \rightarrow CO2}$	11,313*	0.369	16,215*	5797*
	(0.000)	(0.691)	(0.000)	(0.003)
$ARDL_{CO2 \rightarrow FDI}$	0.349	38,507*	8791*	27,303*
	(0.706)	(0.000)	(0.000)	(0.000)

*Indicates significance at the 5% level

integration—I(0) and I(1)—, ARDL bounds testing is the convenient approach to analyse co-integration relationship.

8.3.2 Co-integration Analysis

For each country group; ARDL models was estimated in two ways, at first including FDI as an independent variable, then as an explained variable. The null hypothesis of no co-integration, was tested by chi-squared test. Obtained results for each model are summarized in Table 8.2. Appropriate lag length again was determined according to the Akaike Information Criterion.

As it can be seen from the results in table above, the long-run relationship running from FDI to CO_2 emission was found for high income country panel, whereas opposite result was obtained for upper-middle income country group. Furthermore, the evidence of bi-directional long run relationship among variables was found for both lower middle income and low income country groups.

8.3.3 Causality Analysis

Since the evidence of co-integration relationship was found for all income group countries, the VEC model, obtained based on panel fixed effect regression method, was established for high, upper middle, lower middle and low income country groups (Table 8.3).

As it can be seen from the table above, error correction term (ECT) is statistically significant at an alpha level of 0.05, which implies that, the long-run causal relationship running from FDI to CO_2 emissions has been proven to be valid for high income, lower and lower middle income country groups.

Table 8.3 Panel causality tests

	High income country panel		Upper-middle income country panel		Lower-middle income country panel		Low income country panel	
	Long-run	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run	Short-run
	ECT	F-values	ECT	F-values	ECT	F-values	ECT	F-values
$FDI \rightarrow CO_2$	−4.058*	0.769(−)	–	–	−0.011*	0.701*(+)	−4.014*	1.225(−)
	(0.000)	(0.613)			(0.000)	(0.005)	(0.000)	(0.295)
$CO_2 \rightarrow FDI$	–	–	−7.724*	3.888*(+)	−4670*	13,88*(−)	7.723*	0.620(+)
			(0.000)	(0.049)	(0.000)	(0.000)	(0.000)	(0.539)

*Indicates significance at the 5% level. The parenthesis implies the sum of the coefficients

8.4 Conclusion

This study examined the impact of FDI inflows and CO_2 emissions for 139 country panel for the period of 1970–2015. For this purpose, firstly we investigated whether series have unit root or not. Then a co-integration analysis was done. The results of the various panel stationary tests propose inconclusive results on the order of integration—I(0) and I(1). That is why we estimated an ARDL model, to investigate the co-integration relationship between the series. In order to examine long run dynamics of variables, VEC model and Granger causality analysis techniques were used. The obtained empirical result can be concluded as follows. To begin with, the causal relationship between FDI and CO_2 emission for countries differs depending on which income group country belongs to. According to our results the long-run causal relationship running from FDI to CO_2 emissions has been proven to be true for high income, lower and lower middle income country groups. However, opposite long-run causal relationship is supported only for upper middle income county panel.

Secondly, there is a bidirectional short-run Granger causality between FDI and CO_2 emission for lower middle income country panel implying that, carbon dioxide emission and investment inflows are jointly determined and simultaneously affected (Omri et al. 2014). It seems to support the pollution haven hypothesis for this income country panel in the short run. This evidence, which overlaps with the results of the Shahbaz et al. (2015) may be explained by the fact that, insufficient economic conditions in these countries, such as high input cost, inadequate infrastructure facilities and institutional quality, which cannot stimulate foreign capital inflows, and cause to adopt non-restrictive environmental regulations in lower middle income countries, in order to attract more FDI inflows. Moreover, 'innocent' pollution havens may arise when lower income countries are less able to afford costs of implementing and monitoring environmental regulations (Hoffmann et al. 2005: 316).

Finally, there is not a statistically significant short-run causality relationship running from FDI to CO_2 emission for high income, upper middle income and low income group countries. This result may be explained by the fact that, low income countries are in the first stages of development, in which production process is still based on conventional and non-energy based technological methods (Telatar 2015: 122). Therefore, increasing in investment and production levels does not affect CO_2 emission rates. On the contrary, since high income and upper middle income countries use advanced and environmentally friendly production technologies, the expanding in foreign capital inflow and production rates have no impact on the environment indicators in these country groups.

In terms of further academic research, the investigation of the causal relationship between FDI and pollution indicators can be extended by applying non-linear panel causality techniques which allow nonlinearity and heterogeneity of units to be utilized along with using all information carried by both cross-section and time series data.

Appendix

Table 8.4 List of the analysed countries

	High income	Low income	Lower middle income	Upper middle income
1	Austria	Benin	Bangladesh	Albania
2	Australia	Cambodia	Bhutan	Algeria
3	Bahamas, The	Congo, Dem. Rep.	Bolivia	Angola
4	Bahrain	Eritrea	Cambodia	Argentina
5	Belgium	Ethiopia	Cameroon	Azerbaijan
6	Brunei Darussalam	Haiti	Congo, Rep.	Bosnia and Herzegovina
7	Canada	Korea, Dem. People's Rep.	Cote d'Ivoire	Brazil
8	Chile	Liberia	Djibouti	Bulgaria
9	China	Mali	Egypt, Arab Rep.	China
10	Croatia	Mozambique	El Salvador	Colombia
11	Cyprus	Nepal	Ghana	Cuba
12	Czech Republic	Tanzania	Guatemala	Costa Rica
13	Denmark	Togo	Honduras	Dominican Republic
14	Estonia	Zimbabwe	India	Dominica
15	Finland		Indonesia	Ecuador
16	France		Kenya	Gabon
17	Germany		Kosovo	Georgia
18	Greece		Mongolia	Iran, Islamic Rep.
19	Hong Kong SAR,		Morocco	Iraq
20	Hungary		Nicaragua	Jamaica
21	Iceland		Nigeria	Jordan
22	Ireland		Pakistan	Kazakhstan
23	Israel		Philippines	Lebanon
24	Italy		Senegal	Libia
25	Japan		Sri Lanka	Mauritius
26	Korea, Rep.		Sudan	Macedonia, FYR
27	Kuwait		Syrian Arab Republic	Malaysia
28	Latvia		Tajikistan	Maldives
29	Lithuania		Tunisia	Mexico
30	Luxembourg		Ukraine	Montenegro
31	Netherlands		Uzbekistan	Namibia
32	Norway		Vietnam	Panama
33	New Zealand		Yemen, Rep.	Paraguay
34	Oman		Zambia	Peru
35	Poland			Romania
36	Portugal			Serbia

(continued)

Table 8.4 (continued)

	High income	Low income	Lower middle income	Upper middle ıncome
37	Qatar			South Africa
38	RussianFederation			Thailand
39	San Marino			Turkey
40	Saudi Arabia			Venezuela, RB
41	Singapore			
42	Slovak Republic			
43	Slovenia			
44	Spain			
45	Sweden			
46	Switzerland			
47	Trinidad andTobago			
48	UnitedArabEmirates			
49	United Kingdom			
50	United States			
51	Uruguay			

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Part III

Geostrategy

Geostrategic Challenges in the Oil and Gas Sectors

9

Volkan Ş. Ediger and Istemi Berk

Abstract

This chapter identifies the major geostrategic challenges that have emerged during the last two decades and assesses their implications for the global oil and gas sectors. The historical development of oil prices shows that there have been two major periods of volatility, 1973–1986 and 1998–present, each of which was preceded by two relatively stable periods. The two oil price shocks of the 1970s that were triggered by geopolitical events had long-term effects on global politics and economics. Major oil and gas producers faced the challenges of declining consumption on the demand side, as consumers turned to alternative energies, energy efficiency improved, and non-Organization of Petroleum Exporting Countries (OPEC) oil supplies increased. The crisis in the 2000s, on the other hand, had similar but more intense consequences, deeply altering the structure of oil and gas markets. We identify two major challenges facing the oil and gas industry: energy substitution and resource scarcity. While the substitution of coal and renewables threatens to reduce oil and gas demand, resource scarcity is expected to promote the development of unconventional hydrocarbon resources such as shale oil and gas and heavy oil. Unlike in the 1970s, oil consumption did not decline when oil prices peaked in the 2000s. Moreover, the recent fall in oil and gas prices created a fiscal challenge for conventional producers, such as OPEC countries, and non-OPEC countries like Russia and Mexico, whose governmental budgets depend on export revenues. These fiscal challenges are expected to increase competition between national oil companies (NOCs) and international oil companies (IOCs), necessitating structural change in the governance of the industry. The NOCs are expected to continue dominating

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the industry and due to the increasing intervention of the corresponding governments, the next decades could experience a rise in state capitalism not only in major oil and gas producing countries but also in the global energy business.

Keywords
Oil and gas sectors · Geostrategic challenges · Structural changes · NOCs and IOCs · State capitalism

9.1 Introduction

Petroleum (oil and gas) has been one of the most influential commodities in human history, deeply altering society since the first modern oil wells were drilled in the middle of nineteenth century. As the lifeblood of modern civilization it has improved the human welfare by providing cheap and abundant energy to fuel economies (McNally 2017). It has also been a hard-power tool in global geopolitics, prompting crisis, conflict, and instability for more than a century. We agree with Salameh (2004, pp. 633–634): "No other commodity has been so intimately intertwined with national strategies and global politics and power as oil."

The bidirectional relationship between global energy geopolitics and oil was evident during the periods of major price upheaval in the 1970s and 2000s. In this chapter, we identify two major, contemporary geostrategic challenges, energy substitution and resource scarcity in these periods and their possible implications for the oil and gas sector. We have also narrowed the scope of the study to analyzing how energy substitution and resource scarcity would structurally affect the two most important groups of actors in the market, international oil companies (IOCs) and national oil companies (NOCs), in the context of economic liberalism and mercantilism. We suggest that these geostrategic challenges will increase competition between IOCs and NOCs and might lead to a rise in the application of state capitalism in the governments of NOCs.

The chapter is structured as follows: Section 9.2 provides an overview of the two crisis periods and the two relatively stable periods for oil and gas markets over the last 50 years. Section 9.3 is devoted to the major geostrategic challenges facing oil and gas sectors, and Sect. 9.4 investigates the consequences of these challenges for oil and gas markets. The aim of Sect. 9.5 is to reveal the rise in competition between IOCs and NOCs. Section 9.6 investigates how state capitalism has become a notable trend affecting the governance of NOCs. Finally, Sect. 9.7 concludes.

9.2 Oil Prices and Phases

The oil price graph of the last 50 years is characterized by two crisis periods—1973–1986 (Phase II) and 1998-present (Phase IV)—and two relatively stable periods—1861–1973 (Phase I) and 1986–1998 (Phase III), each of which preceded

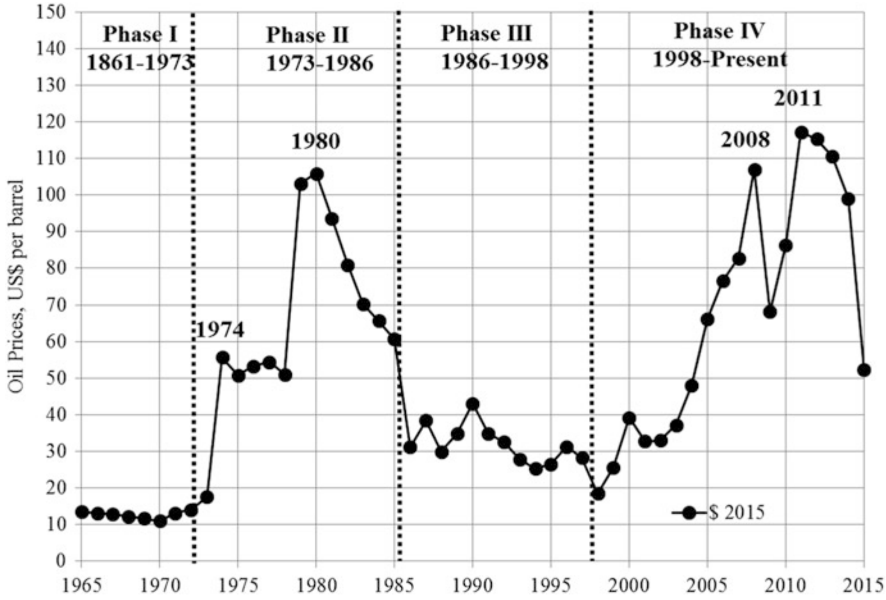

Fig. 9.1 Historical development of oil prices and phases, 1965–2015. Data from BP (2016)

the crisis periods (Fig. 9.1). The crisis periods are characterized by four major peaks, of which two occurred in 1974 and 1980 in Phase II and the other two in 2008 and 2011 in Phase IV. The last two per-barrel price peaks, the third ($107.06)[1] and the fourth ($117.23), occurred similarly but at levels higher than the earlier two, the first ($55.69) and the second ($105.94) in fixed prices. On the other hand, during the relatively stable periods, oil prices reached a high of $20 (equivalent to $2–$3 in the money of the day) per barrel in the first phase and swung between $18 and $43 with an average of $30.95 per barrel in the third phase (1986–1998). At present, prices have fallen continuously since 2011 up to $52.39 in 2015.

Oil prices change over time for many reasons. The Energy Information Administration (EIA) of the U.S. Department of Energy has identified seven key factors that influence oil markets (EIA 2014), including Organization of Petroleum Exporting Countries (OPEC) and non-OPEC supply and demand, global supply balances, spot prices, and financial markets. Some market analysts examine these factors in each case to explain why prices rise or fall. Others try to explain the forces that change these factors, including developments in international politics and geopolitics during the record highs and lows in oil prices since the 1970s.

Oil-price volatility affects different countries in different ways, depending on their social and economic structure. For instance, major consuming countries have

[1]The numbers correspond to annual averages of the Brent crude oil prices. Hence, although in summer of 2008 oil prices skyrocketed to roughly $147/bbl, the annual average of 2008 was roughly $107/bbl.

benefited from cheap, abundant oil in Phases I and III, whereas Phases II and IV caused serious economic and political instability in many parts of the world. Having studied the effects of 32 different geopolitical events on real oil prices between 1861 and 2011, Noguera-Santaella (2016) mapped the relationship between conflicts and oil prices and found that geopolitical events caused oil prices to rise prior to 2000, but have had little, if any, impact since 2000.

Geopolitical factors were more consequential for oil prices during crisis periods, and conversely, oil crises had several implications for global geopolitics. It was actually a genuine chicken-and-egg situation: geopolitics have affected prices, and the resulting prices have changed geopolitics. In fact, it can be a vicious circle in which one problem causes another problem, which compound the first problem. Emerson (2015) explains this situation as the cyclic variation of geopolitics, energy security, crude export ban, and low prices.

For instance, resource nationalism followed by the Organization of Arab Petroleum Exporting Countries' (OAPEC) embargo in 1973/74 can be considered as one of the main reasons for the oil crises in Phase II. The quadrupling in oil prices, in turn, had unintended consequences. First, major oil-consuming countries in the West shifted from oil to alternative energy sources such as coal in the short term and nuclear and renewables in the long term. They also increased energy efficiency and changed their consumption patterns, decreasing global demand for oil. Second, high prices prompted the industry to develop new and costly non-OPEC resources in the North Sea, Alaska, and the Gulf of Mexico, leading to a substantial decline in OPEC's share of the world's oil supply.

Similar but different interacting dynamics were at play in Phase IV. The global economic dynamics affecting the global oil and gas demand in 2000s, followed by the 2008 credit crunch, influenced the third and fourth oil shocks in this phase, which is also called an "era of volatile prices" or "crude volatility" by some authors such as McNally and Levi (2011) and McNally (2017). Oil prices fell continuously after peaking in 2008 and 2011. There are varying interpretations for why oil prices fall, including prolonged oil surplus (Baffes et al. 2015) or reducing global oil consumption (Yetiv and Fowler 2011). Yet Khan (2017, p. 409, 425) argues that the supply-and-demand formula cannot be implemented to the post-2014 decline and instead cites a number of short- and long-term factors: a surge in supply due to the U.S., Canadian, Brazilian unconventional[2] revolution, robust production from Saudi Arabia and Iraq, change in OPEC's policy objectives, a slowdown in the Chinese economy that has diminished expectations of future demand, a rapid rise in the value

[2]Unconventional oil and gas is described as "any source of hydrocarbons that requires production technologies significantly different from those used in currently exploited reservoirs" by IEA (2013, pp. 29–30). Unconventional oil includes kerogen shale (also referred to as oil shale), oil sands, light tight oil (LTO, and oil derived from coal-to-liquids (CTL) and gas-to-liquids (GTL) technologies; whereas unconventional gas is divided into four broad categories such as tight gas, shale gas, coal-bed methane (CBM), and methane hydrates.

of the dollar relative to other currencies, and even the geopolitical strategies of the USA and Saudi Arabia.[3]

The record high peaks followed by falling prices altered markets significantly. Energy substitution occurred from oil to coal and also renewables, while high prices triggered enormous investment and supply from unconventional resources, particularly shale oil and gas and heavy oil. Demand for oil did not change significantly, but investments in renewables rose and over-supply in unconventional petroleum drove the prices down. The price collapse created several geostrategic challenges, especially for conventional producers. The fall in prices caused fiscal challenges for NOCs and IOCs. While IOCs have surmounted these challenges with technological and efficiency improvements, NOCs, which depend on their governments, have been more negatively affected.

Lower oil prices stimulate economic activity in net oil and gas importing countries but hamper it in net exporting countries (Emerson 2015). For instance, the economic and national security implications of high volatility in global oil prices are abrupt, especially in the USA and European Union (e.g., McNally and Levi 2011). On the other hand, lower prices will adversely affect Russia and producing countries in the Middle East (e.g., Gause 2015). Iran's goal of becoming a dominant power in the Middle East threatens Saudi Arabia and the other Gulf countries (Yergin 2016). However, nowhere are the geopolitical consequences of low oil prices more unpredictable than in the Middle East (Guardian 2016).

9.3 Major Geostrategic Challenges

The oil and gas industry has faced two main challenges since the 1970s: (1) energy substitution and (2) resource scarcity.

9.3.1 Energy Substitution

Energy substitution means replacing one energy source with another as a result of long-term competition. It is the most significant challenge that the industry faces. The driving force of the competition between energy sources is based primarily on the energy content (calorific value), practicability in use (state of the matter as solid, liquid or gas), and environmental friendliness (cleanness), which are dependent on the hydrogen-to-carbon ratio of the organic components in fossil fuels (Ediger 2011a, b).

Substitution of wood with coal, coal with oil, and finally oil with natural gas can be seen clearly in the concentration diagram, which charts the share of each energy source in world's energy consumption since the industrial revolution [see Ediger

[3]Khan (2017, pp. 419–420, and references therein) also gives the details of all manner of conspiracy theories, which launched as a result of sudden collapse in crude oil prices.

(2011a, b) for more details]. While wood dominated the global energy system, coal replaced it by increasing its share until it reached a peak of 72% in 1913. This year also corresponded to the shift of the engines of naval warships from coal-fired to oil-fired in Great Britain, then the world's then hegemonic power, with Germany, the major challenger, and the United States following closely behind. The competition between coal and oil intensified during the First World War and continued until 1973, when the share of oil in global energy mix peaked at 49%.

These long-term energy shifts have been complicated by some short- and medium-term inter-fuel substitutions that accompanied the crises of the 1970s (Fig. 9.2). The price shocks led many oil-consuming nations to redefine the term "energy security" and to diversify how they would meet their ever-increasing energy demand. Inter-fuel substitution, for instance, intensified as a way to decrease dependence on foreign oil. The energy world entered into a new age called "the age of substitutability" and the use of energy itself changed, with quantities and quality interacting in ways that are referred to as energy transitions (e.g., Goeller and Weinberg 1976).

It is not a coincidence that the peak of the world's oil consumption corresponded to the first crisis period (Phase II). Resource nationalization in the early 1970s followed by the Yom-Kippur War and OAPEC's decision to embargo oil sales to the United States, the Netherlands, Portugal, Rhodesia, and South Africa created a structural change in the global energy system, quadrupling oil prices and altering energy-consumption patterns. Many countries substituted domestic resources such as coal and nuclear for oil to diversify their energy supply and reduced dependence on foreign sources. From 1973 to 1986, coal use increased from 1533.6 million tons of oil equivalent (MToe) (27.0%) to 2099.1 MToe (28.6%) and nuclear from 45.9 MToe (0.8%) to 361.3 MToe (4.9%) (Fig. 9.2). Coal stopped declining as a share of the global energy mix, while natural gas continued at a relatively constant rate to increase from 1044.8 MToe (18.4%) to 1496.5 MToe (20.4%). Oil, on the other hand, declined in 1973–1975 from 2767.5 MToe (48.7%) to 2696.7 MToe (47.0%) and in 1979–1983 from 3104.3 MToe (46.5%) to 2762.3 MToe (41.4%), resulting an overall decrease from 48.7% to 39.7%. The world's oil consumption at present would have been at much higher levels if the first and second oil crises have not occurred. Instead, oil consumption has been 95 million barrels/day in 2015, with a significant amount of saving. In short, the market share of oil (−9.0%) is replaced by nuclear (4.1%), natural gas (2.0%), coal (1.7%), hydro (1.0%), and renewables (0.1%) in Phase II (Table 9.1).

In Phase III, relatively low, stable prices caused the share of oil, which had been declining since 1973, to reassume a more horizontal trend similar to coal. Oil consumption continued to increase but with a lower rate similar to the pre-1973 period from 2911.8 MToe in 1986 to 3481.5 MToe in 1998 to keep up with relatively stable shares in total of 39.7% and 38.7%, respectively. The rate of increase in natural gas use was also similar to oil (Fig. 9.2). On the other hand, coal's share decreased from 28.6% to 25.4% and oil's share from 39.7% to 38.7%, which were replaced by increases in natural gas from 20.4% to 22.8% and nuclear

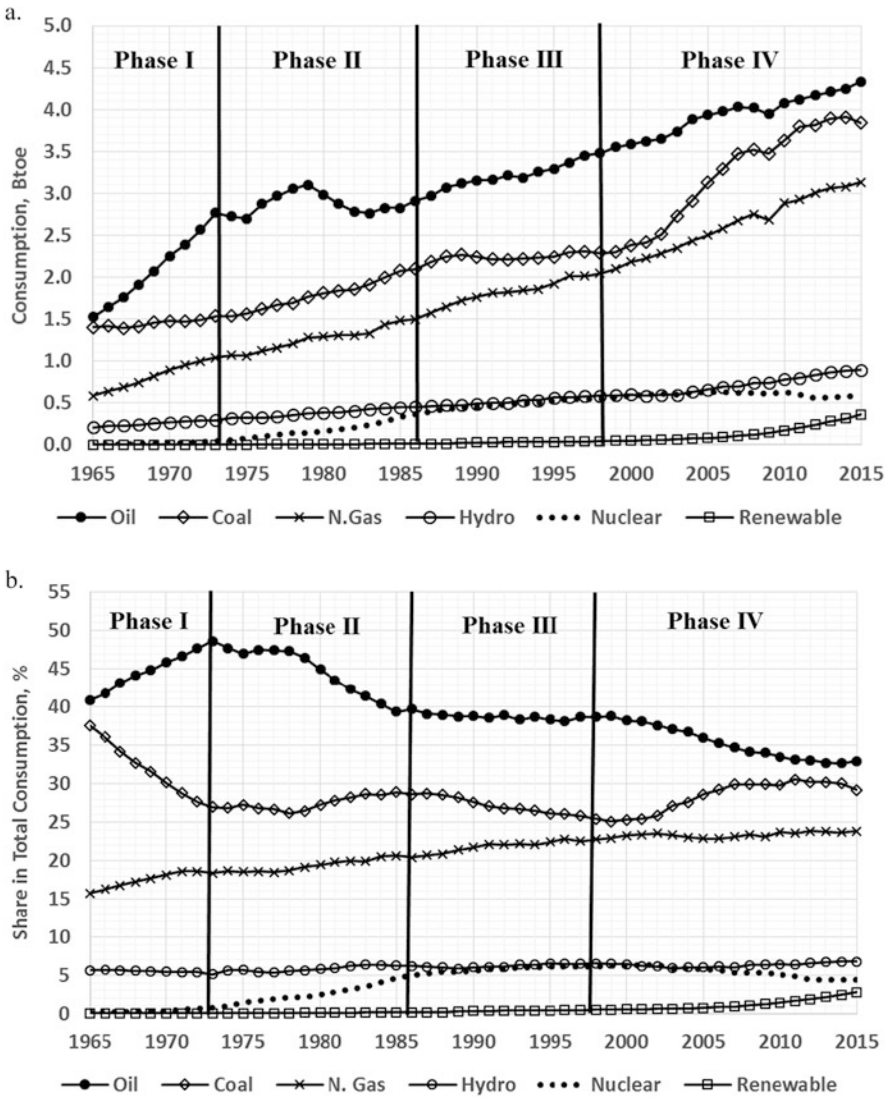

Fig. 9.2 Energy substitutions. Sources: BP (2016). (**a**) Consumption of energy sources in billion tons of oil equivalent (BToe). (**b**) Consumption as share in total in percentages (%)

from 4.9% to 6.1%, as well as minor amounts with hydro and renewables. In this relatively stable phase, energy substitution was insignificant (Table 9.1).

Energy substitution was quite different in the second crisis period, Phase IV, which is most notable for its abnormal increase (68%) in coal from 2288.4 MToe to 3839.8 MToe (Fig. 9.2). Though the long-term historical trend would have predicted that coal's share would continue to decline, coal instead began replacing natural gas.

Table 9.1 Changes in share of energy sources in world's energy mix

%	Phase II 1973–1986	Phase III 1986–1998	Phase IV 1998–2015
Oil	−9.0	−1.0	−5.7
Coal	1.7	−3.2	3.8
Natural gas	2.0	2.4	1.1
Hydro	1.0	0.3	0.3
Renewables	0.1	0.3	2.3
Nuclear	4.1	1.2	−1.7

The driver of this change was China's enormous consumption of coal, which is the country's most prolific domestic energy source. Starting with 1998, China increased its coal production exponentially from 666 MToe to 1827 MToe and consumption from 673.4 MToe to 1920.4 MToe. At present China is responsible from 47.7% of world's coal production and 50.0% of world's coal consumption. Due to increases in coal consumption, oil's share also decreased from 38.7% to 32.9%, but oil consumption continued to increase on a global scale, as it has since 1983, from 3841.5 MToe in 1998 to 4331.3 MToe in 2015. Significant decreases which occurred in Phase II as a result of high oil prices are also not seen in Phase IV. In other words, high oil prices did not affect oil consumption, primarily due to the developments in unconventional oil and gas.

Phase IV distinguishes from Phase II through another channel, namely renewable energy consumption. Renewable energy sources other than hydro increased their shares to a much higher value in this phase from 43.4 MToe (0.5%) in 1998 to 364.9 MToe (2.8%) in 2015. On the other hand, while hydro was in increasing trend in real amounts and percentages in both phases, nuclear was increasing in the first one while decreasing in the second one (Fig. 9.2). In short, in Phase IV, oil (−5.7%) and nuclear (−1.7%) were substituted by coal (3.8%), renewables (2.3%), natural gas (1.1%), and hydro (0.3%) (Table 9.1).

The most important implication of energy substitution and multiple-energy dominancy is the decline in oil and gas demand, which threatened Russia and OPEC countries, whose economies rely heavily on oil and gas export revenues. The re-entry of Iran, which has been under U.S. embargo since 1996, into international markets and the tendency of consuming countries to harness their domestic resources and increase energy efficiency further complicated the situation.

Having considered the close integration of the oil and gas sectors, the historical development of the share of hydrocarbons (oil and gas together) in the energy mix demonstrates the problem of shrinking demand (Fig. 9.3). At present, we consume around 7.5 billion tons of oil equivalent (BToe) of hydrocarbons, of which 58% is oil and 42% is natural gas. The share of hydrocarbons in the total energy mix continuously decreased after it peaked at 67% in 1973 (end of Phase I) to 50.5% in 1988 (near the end of Phase II) as a result of short-term inter-fuel substitution and increased efficiency in oil. It then rose to 61.7% in 1999 (near the end of Phase III) because of cheap and stable oil prices. In Phase IV, it has decreased similar to

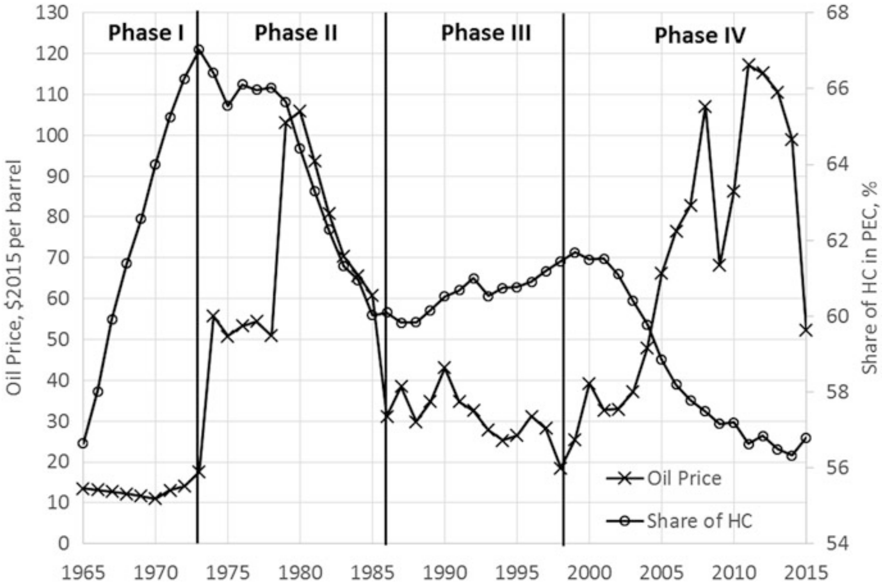

Fig. 9.3 Share of hydrocarbons (oil and gas) in energy mix and oil prices. Sources: BP (2016)

Phase II, falling to 56% in 2015. Unless circumstances change, oil and gas demand will continue to decline.

The correlation between prices and shares also changed considerably in Phase IV. The positive correlation between the two curves changed into a negative correlation. The share of hydrocarbons and oil prices decreased similarly in Phase II and followed a stable period in Phase III, however, both changed their patterns in Phase IV. This would mean that global hydrocarbon consumption patterns have become more inelastic to oil prices. Therefore, future demand for oil and gas should not be related with oil prices and energy substitution will remain as a major challenge in the oil and gas sector.

9.3.2 Resource Scarcity

The second major geostrategic challenge is resource scarcity, which triggered the rise of oil prices especially in crisis periods. It is not a coincidence that international awareness of the finite nature of fossil fuels started during Phase II. The publication in 1972 by the Club of Rome of the book, *Limits to Growth*, prompted Western governments to recognize the finite nature of fossil fuels and emphasize that petroleum is an exhaustible resource (Meadows et al. 1972). A Blueprint for Survival, where the word "sustainability" was first used, noted the inevitable end of our civilization if current trends are allowed to (The Ecologist 1972). Finally, the

Table 9.2 Largest reserve additions in oil, natural gas, and hydrocarbon, 1980–2015

1980–2015	Oil			Natural gas			Hydrocarbon		
	Year	Btoe	%	Year	Btoe	%	Year	Btoe	%
1	1999	19.0	13.7	2001	13.0	12.5	1999	22.0	9.1
2	2010	14.6	10.6	1989	9.6	9.3	2010	21.1	8.7
3	1986	14.3	10.4	2011	8.3	8.0	1986	19.7	8.1
4	1988	12.0	8.7	2008	7.2	7.0	2008	16.9	7.0
5	2008	9.7	7.0	2010	6.5	6.3	1988	15.7	6.5
6	1991	9.6	6.9	2000	5.4	5.2	1991	14.3	5.9
7	2002	6.7	4.9	1986	5.3	5.2	2011	13.6	5.6
8	2009	5.4	3.9	1991	4.7	4.5	2001	13.6	5.6
9	2011	5.3	3.8	1988	3.7	3.6	1989	9.7	4.0
10	1984	5.1	3.7	1996	3.3	3.2	2002	8.1	3.3
Total		101.7	73.5		67.0	64.6		154.6	63.8
Overall total		138.4	100.0		103.8	100.0		242.1	100.0

UN Conference on the Human Environment, better known as the First Environment Summit, was held in Stockholm, from 5–16 June 1972.

New discoveries of conventional oil and gas are decreasing. The proved reserves of oil and gas have increased almost linearly with slightly varying rates between 1980 and 2015. However, increases of reserves are much larger in some years than in others, such as 1999, 2010, 1986 in oil, and 2001, 1989, 2011 in gas (Table 9.2). Moreover, some countries have had much larger reserve additions than the others. For instance, 62% of the 1014.2 Bbbls oil reserve additions between 1980 and 2015 were made in only seven years (1999, 2010, 1986, 1988, 2008, 1991, and 2002) and in four countries (Venezuela, Canada, Iraq, and Iraq). The largest reserve additions by country from 1980 to 2015 were made from unconventionals such as heavy oils in Venezuela (281.3 Bbbls) and oil sands in Canada (132.7 Bbbls). Most of the remaining additions came from the conversion of resources to proven reserve categories in traditional oil-producing countries such as Iran and Iraq, whose industries have been retarded by sanctions, conflict, or war.

The recent crude oil reserve additions, mostly in the form of unconventional oil such as tight oil and tar sands, altered the ranking of the largest reserves by country. Venezuela and Canada, which used to be eleventh and sixth in 1980, are now first and third, respectively. From 1980 to 2015, Iran kept its place as fourth with some fluctuations, while Iraq rose from ninth in 1980 to fourth in 2015. Yet the largest changes occurred in Venezuela and Canada due to new discoveries of unconventionals. Of Venezuela's current oil reserves, roughly 74% are heavy oils; of Canada's, 97% are from oil sands. All countries except Saudi Arabia in the top five produce oil in amounts incomparable with their reserves. The shares of reserves and production in total are 18% and 3% in Venezuela, 10% and 5% in Canada, 9% and 4% in Iran, and 8% and 5% in Iraq, respectively. On the other hand, the same ratios are 3.2% and 13.0% in the United States and 6.0% and 12.4% in Russia, which are the second- and third-largest oil producers, respectively. The only country that has production (13%) comparable with its reserve (15.7%) is Saudi Arabia. This situation reveals that unconventionals in Venezuela and Canada and conventionals in Iran and Iraq will play crucial roles in the future.

On the other hand, the largest natural gas reserve additions from 1980 to 2015 were made by Qatar (21.7 trillion cubic meter, Tcm), Iran (19.9 Tcm), Turkmenistan (17.5 Tcm),[4] Saudi Arabia (5.1 Tcm), the USA (4.8 Tcm), Venezuela (4.4 Tcm), Nigeria (3.9 Tcm), UAE (3.7 Tcm), and Australia (3.3 Tcm). Iran, Qatar, Turkmenistan, and the United States displayed unique characteristics. Iran gradually increased its reserves by 18.9 Tcm, from 14.2 Tcm in 1988 to 33.1 Tcm in 2010. Qatar increased its reserves first gradually by 5.7 Tcm from 2.8 Tcm in 1980 to 8.5 Tcm in 1997 and then sharply by 17.3 Tcm from 1997 to 2001. Turkmenistan grew its reserves by 15.2 Tcm from 2.3 in 2007 to 17.5 Tcm in 2011. Yet all of these additions were made from conventionals, whereas U.S. reserves shifted in 1998 from decreasing to increasing and reserves climbed by 5.8 Tcm from 4.6 Tcm in 1998 to 10.4 Tcm in 2015.

In 2015, the largest gas reserves are in Iran, Russia, Qatar, Turkmenistan, and the United States with shares in total as 18.2%, 17.3%, 13.1%, 9.4%, and 5.6%, respectively. On the other hand, the leading producers by share of total production are the United States (22.0%), Russia (16.1%), Iran (5.4%), Qatar (5.1%), and Turkmenistan (2.0%). The shares in production are much smaller than those of reserves in Iran, Qatar, and Turkmenistan but relatively similar in Russia. On the other hand, U.S. production is roughly four times higher than its share of reserves. U.S. production has surged because of unconventional, particularly shale, gas resources. Unlike oil reserves, the ranking of countries by gas reserves has not changed significantly. In 1980, the largest reserves were in Russia, Iran, the United States, Algeria, Saudi Arabia, and Qatar with only Algeria being replaced by Turkmenistan.

Figure 9.4 illustrates the U.S. "shale gas revolution." The country's dry gas gross production peaked twice, once at 21.7 trillion cubic feet (Tcf, hereafter) in 1973 and again at 19.6 Tcf in 2001. After 2001, production decreased for four years but rose again from 18.1 Tcf in 2005 to 27.1 Tcf in 2015. The reason that production increased while withdrawal from gas wells decreased is the enormous production from shale gas reserves, with shale gas production exceeded withdrawal from gas wells for the first time in 2013. In 2015, more than half (57.2%) of U.S. dry gas production was shale.

According to data from the EIA, the country's proved natural gas reserves as of end of 2015 are 324.3 Tcf of which 54% is shale gas (175.6 Tcf).[5] According to the latest data from EIA/ARI (2013), technically recoverable shale gas resources in the world is 7795 Tcf of which 14.9% is found in the USA, 14.3% in China, and 10.3%

[4]Since the oldest available data for Turkmenistan in BP (2016) is 2.4 Tcm for the year 1997, the reserve value for this country is taken as zero for 1980.

[5]The shale gas reserves have been revised and decreased to 175.6 Tcf from 199.7 Tcf in year-end 2014. In 2015 25.9 Tcf is discovered and 15.2 Tcf is produced.

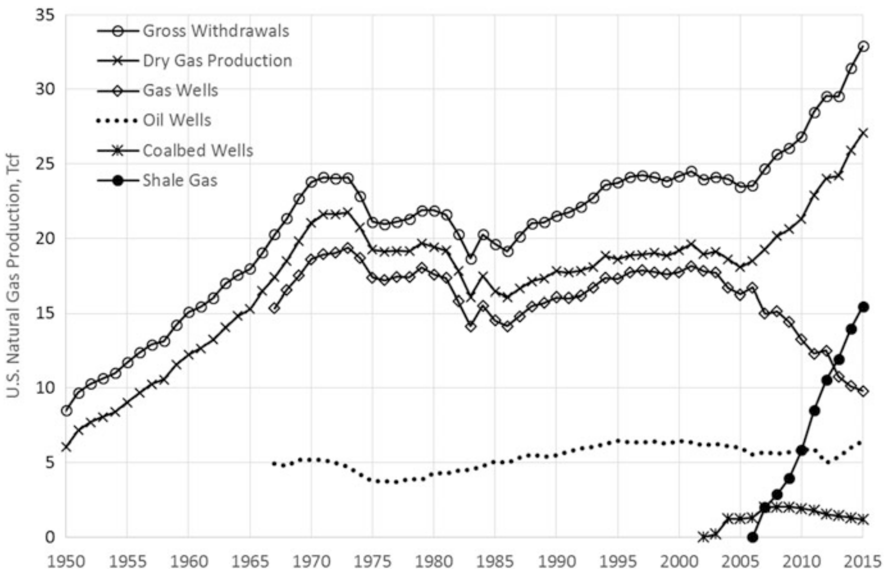

Fig. 9.4 U.S. Natural gas withdrawal and production, 1950–2015. Source: EIA (Data available at: https://www.eia.gov/dnav/ng/NG_PROD_SUM_DC_NUS_MMCF_A.htm. Access Date: 28.06.2017)

in Argentina. This much of unconventional gas reserves is enormous compared to world's conventional gas reserves of 6599 Tcf. On the other hand, the world's proved oil reserves (1697.6 Bbbls) are roughly five times larger than the technically recoverable shale oil resources (335 Bbbls), of which 22.4% are found in Russia, 14.3% in the United States, and 9.6% in China (EIA/ARI 2013). Therefore, shale gas is likely to be more important than shale oil in the future.

Yet contradictory ideas exist about the future of unconventional oil and gas. Some authors argue that production is unsustainable for two reasons. First, fast depletion rates mean that persistent investment is needed to sustain production, but the low oil price environment, which is expected to continue for some time, dissuades investment (Sovacool 2014). Second, unconventional production carries environmental consequences due to the use of fracking technology and offshore leakages (Evensen et al. 2017). On the other hand, conventional oil and gas production will decline at some point (Campbell 2015), and resource scarcity is expected to be a challenge not because of the end of oil but rather the "end of cheap oil," as suggested by Campbell and Laherrère (1998).

9.4 Changes in Market Dynamics

During the period between 1986 and 1998, low, stable prices threatened the national oil companies, especially after major non-OPEC discoveries decreased the power of OPEC countries. Similar effects occurred in the last period of crisis.

Starting from 1998, global demand for oil and gas started to climb, causing prices to rise until the global financial crisis in 2008. Although skyrocketing oil prices temporarily halted demand growth and caused prices to fall, the global economy recovered quickly, and oil prices rose again from 2009 to $117.23/bbl in 2011. High prices during the 1998–2008 period led to two major developments in global oil and gas markets. First, high-cost resources, especially U.S. shale oil and gas, became economically feasible to produce, which caused a surge in global supplies. Second, a massive increase in investment in clean coal and renewable energy technologies, especially in major consuming countries, decreased the future expected demand for fossil fuels. These developments began to affect markets in the peak of annual average oil prices in 2011. Prices then remained relatively high for three years, before collapsing in 2014.

The price collapse has severely affected certain producers of oil (mainly OPEC countries) and gas (mainly Russia and Qatar). Although these conventional producers have low marginal-production costs, their economies and government budgets greatly depend on oil and gas export revenues. In spite of the expectation that low prices would cause investment in higher-cost resources to decline, U.S. production of shale oil and gas continued to increase due primarily to lower costs brought on by more efficient technology. Hence break-even prices for these resources have further declined, making analysts forecast that low prices will continue for the medium term.

Moreover, the shale revolution and corresponding price collapse have altered the market power of certain producers. For instance, the oversupply of U.S. shale gas has caused Henry Hub prices to fall, and gas is now more competitive in the country's power sector. This freed up huge amounts of coal for export to mainly Europe, resulting in a drop in coal prices on the continent and making coal more competitive in power sector than imports of Russian gas. Moreover, the United States has transformed from a major importer of liquefied natural gas (LNG) to becoming self-sufficient in gas and an exporter of LNG. According to International Energy Agency (IEA), The share of LNG in global gas trade is expected to increase more than 50% by 2040. European markets, moreover, are benefitting from the oversupply of global LNG, while Russia's security of gas demand is threatened. Russia has responded by decreased its existing long-term contract prices to protect its market share (Henderson and Mitrova 2015).

Similar developments are observed in the global oil market. The price decline in 2014, driven by the surge in U.S. shale oil, the appreciation of the U.S. dollar, and the abatement of geopolitical conflict, was expected to be corrected by a production cut by OPEC (Baffes et al. 2015). Yet, mainly due to Saudi Arabia, OPEC's response was to keep production levels unchanged. According to Fattouh et al. (2016), Saudi Arabia's policy to protect its market share was logical, assuming that shale oil supply is price elastic, i.e. in the long-term low prices will lead shale production to decline massively. Figure 9.5 illustrates the competition between Saudi Arabia and the United States for global market share since the 1970s. After the price shocks in 1973 and 1978, the United States had the largest share in global oil supply until 1991, when Saudi Arabia overtook it until 2014. Finally, after the

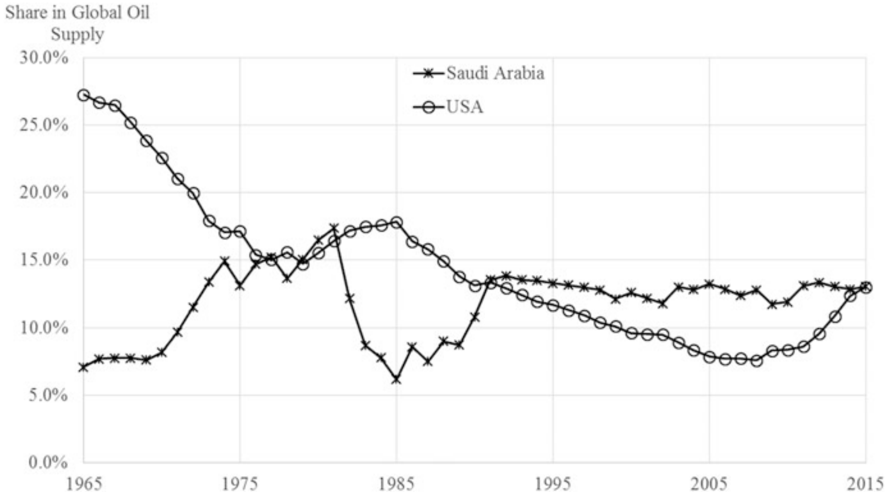

Fig. 9.5 Shares of Saudi Arabia and the USA in Global Oil Supply, 1965–2015. Source: BP (2016)

crisis period of 2014, U.S. production rose to 568.5 million tons, while Saudi production stayed at 567.2 million tons.

Similar dynamics occurred in the gas market between the United States and Russia (Fig. 9.6). The two countries have traded positions as the largest supplier from 1985 to 2010, but the United States has firmly taken the top position since then. Hence, in both oil and gas, maintaining market share is a critical challenge, particularly for national companies of OPEC and Russia and international companies, who will compete against each other.

In summary, energy substitution and resource scarcity have changed market dynamics and increased geopolitical uncertainty. These challenges have intensified the competition between IOCs and NOCs. Specifically, they have created several threats to NOCs because, while IOCs can adapt themselves to the changing business environment, NOCs are less nimble as they depend on the policy targets of their corresponding governments. For instance, the price collapse of 2014 had a minor effect on the private sector, which instead made several innovations, including efficiency gains from technological progress and commercial hedging strategies such as mergers and acquisitions (M&A) and acquiring small companies. On the other hand, NOCs and their state budgets have been fiscally threatened and must undergo significant structural changes in the upcoming years. These changes would occur in all subsectors, including upstream, midstream, and downstream as well as financial and administrative structures. The most expected outcome of these challenges is the rise of state capitalism, which seeks to protect NOCs under changing environment. The next sections of this chapter are dedicated to the rising competition between IOCs and NOCs and (re-)emerging state capitalism for adapting NOCs to changing oil and gas markets.

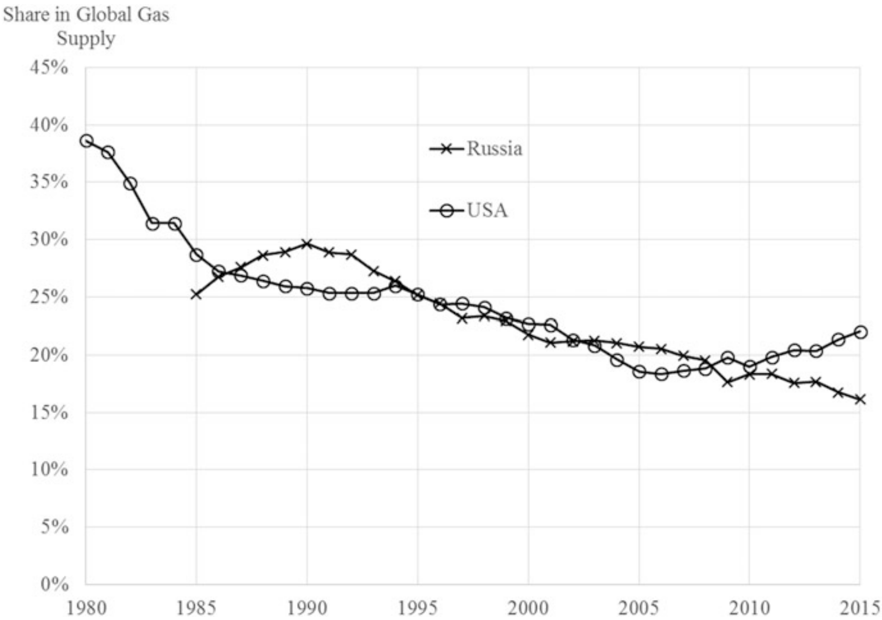

Fig. 9.6 Shares of the USA and Russia in global gas supply, 1980–2015. Source: BP (2016)

9.5 Rising Competition Between IOCs and NOCs

Oil and gas companies are the largest companies in the world because petroleum is the largest single item in the balance of payments and trade between nations and represents the largest share in the world's energy mix. Taxes paid by petroleum companies constitute a major source of revenue for more than 90 countries in the world (Tordo et al. 2011). According to Fortune Global 500 ranking for 2015, six of the world's largest companies are in the energy sector and five of the largest energy companies are oil and gas companies.[6]

Oil and gas companies are traditionally classified as "supermajors," "majors," and "independent."[7] Yet for the last two decades a binomial classification based on ownership has divided companies into NOCs[8] and IOCs. This is preferred because of geopolitical reasons. NOCs are established by governments, regardless of whether they produce or consume oil, to protect and serve the strategic and geopolitical interests of their countries, while IOCs are motivated to make profit (Fisher 2008; Ike and Lee 2014). While most NOCs are owned by states with varying shares and

[6]http://beta.fortune.com/global500/ [Accessed 22/07/2016].

[7]Private companies are sometimes called privately owned oil companies (POCs).

[8]Also called state-owned enterprises (SOEs)

degrees of influences, IOCs are usually multinational and work commercially with common technical and operational methods.

Historically, the oil industry was initiated and developed by private companies, such as the Standard Oil Company founded by John D. Rockefeller in 1870 in the United States. Later, during the First World War, the growing needs for the state to intervene in oil affairs prompted the establishment of NOCs, such as Austria-Hungarian oil refining company in 1908, British Anglo-Persian Oil Company (APOC) in 1914, and French Compagnie Française des Pétroles (CFP) in 1924 (Tordo et al. 2011).

Since the Second World War, international oil and gas markets have undergone substantial transformations in four phases (e.g., Tordo et al. 2011). In Phase I, markets were dominated by IOCs, which operated with concessions given mainly by reserve-owning states. In Phase II, OPEC controlled markets and although some early nationalization efforts were observed, for example of Mexico in 1938, large-scale asset nationalization and establishment of NOCs in many countries took place after 1960s. During the global nationalization of the 1970s, high oil prices provided an opportunity for IOCs to restructure and improve their efficiency levels. In Phase III, markets were characterized by liberalization, deregulation, and privatization, but this faded because of unsuccessful privatization practices and reluctance in OPEC countries to reverse the nationalization trend. For instance, in 1988, Saudi Arabia took control of Arabian American Oil Co. (Aramco) and changed its name to Saudi Arabian Oil Co. (Saudi Aramco). The privatization of state companies in 1990s in the transition towards a market economy in the former Soviet Union and other centrally planned economies did not last long either, due to internal political reasons (Watkins 2008). In Phase IV, when oil prices began rising, state players became more influential than private-sector players. This cyclical pattern between the state and private sector, between NOCs, known as the "Seven Brothers," and IOCs, also known as the "Seven Sisters,"[9] is attributed to changing global energy geopolitics.

In Phase III, the positions of both IOCs and NOCs have also considerably changed; the competition between them intensified, and firms needed to merge or establish strategic alliances or undergo changes in ownership, structure, and corporate strategies to increase their competitive strengths (Odell 1997). Although market liberalization and privatization continued on some levels, many key producers ruled out privatization because of governments' desire to increase their shares in countries' petroleum rents (Linde 2000). This led to the nationalization of NOCs in different degrees or the creation of new NOCs in emerging oil provinces, some producing countries and countries like Russia. Accordingly, the nature of the competition between companies shifted from purely commercial to increasingly political. On the other hand, some net consuming states in the developing world such as China

[9] According to Hoyos (2007), "Seven Sisters" is a term coined in the 1950s by businessman Enrico Mattei, then head of the Italian state oil company ENİ and "Seven Brothers" refer to the recently emerged state-owned oil companies in emerging-market economies, such as Saudi Aramco (Saudi Arabia), China National Petroleum Corporation (China), Gazprom (Russia), National Iranian Oil Company (Iran), Petrobras (Brazil), PDVSA (Venezuela), and Petronas (Malaysia).

and India, supported their NOCs in pursuing acquisitions of overseas petroleum sources. Although the ostensible reasons were sweeping such as oil and gas price fluctuations, overcapitalization, slowed demand growth, and low shareholder returns, the real reason behind it was geopolitics.

One of the most important developments in IOCs was M&A, or taking over other companies as a result of downsizing and cost-cutting operations. M&A activity started after the first oil crises with 10 mergers from 1979 to 1989 and later intensified in the 1990s as a result of low oil prices and the Asian financial crisis (Ediger 2000; Linde 2000). From 1998 to 2002, the industry witnessed mergers of majors such as BP with AMOCO, ARCO, and Burmah Castrol PLC forming BP; Exxon with Mobil forming ExxonMobil; Conoco with Phillips forming ConocoPhillips, Chevron with Texaco forming Chevron, and Total with Petrofina and Elf Aquitaine forming TotalFinaElf. Transaction volume during this period surpassed total M&A activity over the previous century, reaching $2520 billion in 1998 (Cassidy et al. 2001). Later, M&A activity returned to peak levels in 2009 and 2010 with mostly mid-sized deals in unconventionals, as a result of the intense competition between companies in emerging markets (Olivera 2009). M&A activity in U.S. shale oil and gas was robust in 2010, with total acquisition spend reaching $15 billion and $39 billion, respectively (PGJ 2011).

The mergers created giant, integrated IOCs; for instance, ExxonMobil, which had combined the two biggest pieces of Rockefeller's former Standard Oil Company after the U.S. Supreme Court's decided to disband the company in 1911, became the world's largest energy company, and the largest corporation of any type in the world (Showstack 1998). With the merger of Conoco and Phillips in 2002 the third largest US-based oil firm was formed (Fletcher 2002).

The restructuring of IOCs also forced NOCs to undergo structural changes to be more efficient and commercial (Young 2003). The most important change occurred in government intervention, which ranged from the regulation of exploration, production, processing, pricing, and demand, to actual participation in the market through state companies. Another change was from complete state ownership to collaboration with IOCs in a licensing regime. The degree of independence at the managerial level also varied widely. Due to the importance of NOCs for the national economy, governments wanted to increase their control over them, especially in the producing countries (Linde 2000). Government intervention intensified over time as internationalization sharpened the conflict of interests between governments and market players. At present, according to Petroleum Intelligence Weekly (PIW) Top 50 list prepared based on reserve and output data, 15 out of 20 companies are NOCs with state ownership ranging from 28.7% (Petrobras of Brazil) to 100% (Saudi Aramco of Saudi Arabia, NIOC of Iran, CNPC of China, PDV of Venezuela, KPC of Kuwait, Pemex of Mexico, Sonatrach of Algeria, Roseneft of Russia, QP of Qatar, and Sinopec of China) (PIW 2013).

Increasing government intervention also redistributed power among the companies. Prior to the first oil crisis in 1973, the Seven Sisters dominated global petroleum, controlling more than 90% of the world's reserves (Fisher 2008). Since 1973, producing countries gradually nationalized their oil industries and by 2011, NOCs controlled approximately 90% of the world's oil and gas reserves, 75% of production, roughly 60% of the world's undiscovered reserves, and much of the existing oil and gas infrastructure (Tordo et al. 2011). PIW ranks 18 NOCs among the top 25 oil and gas reserves holders and producers (Fisher 2008). The growing power of NOCs has made major competitors with IOCs in the petroleum market (Ike and Lee 2014).

NOCs control of reserves have even forced IOCs to develop new market strategies and have steered IOCs to operate in more expensive and risky alternative sources and geographies (Linde 2000; Fisher 2008). Still, NOCs have not equaled IOCs in commercial success because governments intervene to protect their so-called strategic assets and decrease operational efficiency in the process (Bremmer 2009a). NOC continually underperform IOCs because of their inefficiency in operating in the petroleum industry, government regulation and policy, and governments' interest in using NOCs to pursue other interests (Hartley and Medlock 2008; The Economist 2012). More recently, Ike and Lee (2014) measured the relative efficiency and productivity of 38 NOCs and IOCs, which were among the world's 50 largest oil companies, for the period 2003–2010. The empirical results showed that NOCs from OPEC countries were the lowest performers, while IOCs were the highest.

According to Fortune Global 500 ranking for 2015, among the largest publicly listed oil and gas companies, only CNPC and Sinopec are Chinese NOCs, whereas Royal Dutch/Shell, ExxonMobil, and BP are IOCs registered in the Netherlands/UK, the United States, and the UK, respectively.[10] Similarly, according to Platts Top 250 energy company rankings for 2015, nine of the top 10 and 16 of the top 20 are oil and gas companies.[11] The three largest oil and gas companies are ExxonMobil, Chevron (U.S.) and Royal Dutch/Shell.

Examining modern NOCs in detail, Tordo et al. (2011) concluded that: (1) internal governance mechanisms are more critical to NOC value creation than the ownership structure, (2) NOCs that belong to countries with large resource endowments may find it more difficult to create value than their counterparts in countries with smaller resource endowments, (3) temporary restrictions on access to petroleum activities can be effective policy tools to enhance value creation by the NOC, and (4) the pursuit of national mission objectives does not necessarily hamper the creation of value by the NOC. Governments are expected to continue to interfere with the operations of their state-owned companies over the next decade, during when the geopolitical challenges intensify the competition between IOCs and NOCs. Increasing state intervention would bring a boost in the state capitalism in petroleum industry for the upcoming years.

[10] http://beta.fortune.com/global500/ [Accessed 22/07/2016].

[11] http://top250.platts.com/Top250Rankings [Accessed 22/07/2016].

9.6 State Capitalism

State capitalism or state-managed capitalism is a new model of economic policy, primarily seen in developing countries such as China and Russia. There is no common definition for state capitalism despite its widespread use. Some authors define it as "the use of government-controlled funds to acquire strategic stakes around the world" (Lyons 2007, p. 119), "a system in which governments use capitalism and free markets to advance their own power and interests" (Janjigian 2010), "widespread influence of the government in the economy, either by owning majority or minority equity positions in companies and/or through the provision of subsidized credit and/or other privileges to private companies" (Musacchio and Lazzarini 2012, p. 4) or "state-owned publicly listed corporations" (Carney 2014, p. 838).

State capitalism is, in fact, not a new concept. The history of economic nationalism, which is the precursor of the modern theory of state capitalism, dates to the seventeenth century (Shadrina 2013). C.L.R. James first developed the idea in 1950 in his book, *State Capitalism and World Revolution*, but it did not arouse interest. Comparing the theory of Marxism, Leninism, and Trotskyism, James (1986, p. 11 and 13) concluded, "Russia is a form of state capitalism" and "the theory of state capitalism is the theoretical foundation for this revolution."

State capitalism is developed basically in four phases (Bremmer 2009a, pp. 41, 45–49). In the first phase during the oil crises in 1970s, OPEC members, which had the power of control levels of oil production, were able to capture a much larger share of the revenues generated by the major Western oil companies. The second phase of 1980s and 1990s is characterized by the rise of developing countries controlled by governments with state-centric values and traditions. In this phase, several developing countries such as Brazil, China, India, Mexico, Russia, Indonesia, South Africa, and Turkey entered into a rapid growth and industrialization, by deregulating their state-controlled economies and empowering domestic free enterprise. After the collapse of the Soviet Union, Russia and other newly emerged Soviet republics tried transition to capitalist economies, and waves of privatization washed away state management of many companies and sectors. The third phase was characterized by the rise of Sovereign Wealth Funds (SWFs), state-owned investment portfolios, of which reserves were generated by the huge increase in exports from emerging-market countries, began to challenge Western dominance of global capital flow. Finally, the fourth phase opened with the global financial crisis in 2008 and saw the replacement of the free market by state capitalism as a new economic model. The explosion of state capitalism coincided with the spread of one-party regimes, which offered greater political and financial stability (Carney 2014).

National oil corporations—together with state-owned enterprises, privately owned national champions, and SWFs—are the primary actors of state capitalism (Bremmer 2009a, p. 40). Petroleum is certainly the most important sector for government interventionism and "governmentalization" appeared as a new type of nationalization in the oil and gas sector (Butler 2011). At present, governments already own the world's largest oil companies and control three-quarters of the world's petroleum reserves (Bremmer 2009a). On the other hand, the large majority of SWFs are financed by surplus revenues from oil and gas exports and oil-exporting countries were among the earliest to establish them, such as Kuwait Investment Authority in 1953 (Lyons 2007, pp. 119, 120–125). The largest SWF is ADIA in the UAE; its value exceeded $600 billion in 2015, compromising more than 500% of the country's GDP.

Russia provides excellent examples of state-controlled companies in the energy sector. The government uses the country's natural-gas monopoly Gazprom and largest oil producer Rosneft to implement foreign-policy strategies. For instance, the Russian government took aggressive steps to intervene in the Middle East in order to become the dominant power and to gain leverage over the Gulf States in acquiring exclusive rights, especially for oil and gas sources in the region (Champion and Blas 2016). In December 2016, Rosneft secured its financial position by signing a deal to sell 19.5% of its shares to Qatar Investment Authority (Golubkova 2016). Rosneft also acquired a 35% share in Egypt's giant Zohr gas field, which was discovered by Italian company Eni in 2015. In the same month, Gazprom also signed an initial agreement with Iran to develop two giant oil fields (Sharafedin and Kobzeva 2016).

Although Russia is a prototypical case of state capitalism in energy (e.g., Shadrina 2013; Klimina 2014), China is the best example in which oil companies and other energy companies play a significant role in state capitalism (Du 2014). China has one of the largest number of Fortune Global 500 companies and its energy SOEs such as Sinopec Group, China National Petroleum, and State Grid are among the top-10 firms on the Fortune 500 list.[12] China became the world's second-largest national economy after the United States and is expected to be the first soon.

Chinese SOEs are supervised by an organ of the central government, the State-Owned Assets Supervision and Administration Commission of the State Council (SASAC), which is the world's largest controlling shareholder (Lin and Milhaupt 2013, pp. 669–700). China understood that a centrally planned economy cannot compete with a free-market one and developed a hybrid model to grow the economy while maintaining political control. In the Chinese model, state-controlled companies are used by the government to advance its policies (Bremmer 2010), in other words, the government is literally engineering China's development (Janjigian 2010). The phenomenon is known in Chinese as "guo jin, min tui," or "the state advances, the private sector retreats" (Epstein 2010).

For the most part, though, state capitalism in China remains a "black box" that raises many questions for scholars and policymakers (Lin and Milhaupt 2013, p. 759). The concentration of the level of economic power and influence in the hands of central authorities, for example, could inject populist politics and high-level corruption into economic decision-making (Bremmer 2009a, pp. 40–41). Bremmer (p. 44) also claims that "commercial decisions are left to political bureaucrats, who

[12] http://money.cnn.com/magazines/fortune/global500/2013/full_list/

have little experience in efficiently managing commercial operations. Their decisions often make markets less competitive and, therefore, less productive." The questions asked by *The Economist* in 2012 are still waiting to be answered for the future of new nationalism: "How successful is the model?" and "What are its consequences—both in, and beyond, emerging markets?"

The recent rise of state capitalism, especially in the oil and gas industries, therefore raises several risks for the performance of global markets. State capitalism and its support for national champions, either private or state-owned firms that are chosen to receive government assistance, were considered among the ten threats to market capitalism by the founders and CEOs of some of the world's top companies (Bower et al. 2011). The transfer of power from free markets to states, the retreat of the private sector, and the demolition of free competition and liberal markets will affect the global economy and international politics (Bremmer 2009a, b). On the other hand, Klimina 2014, p. 421) posits that state capitalism could play a beneficial role in "moving market economies toward greater equality and social justice."

Bremmer summarizes the problems of state capitalism for oil and gas markets (Bremmer 2009a, pp. 44–46). One problem will be the decline of entrepreneurs and their investments, which will decrease the overall number of investment because investment decisions may be motivated by political rather than economic factors. NOCs have more cash to spend than IOCs and pay above-market rates to suppliers to lock in long-term agreements. NOCs that provide development loans to a supplier country also will distort markets by increasing the cost that everyone pays for oil and gas. Finally, the development of new hydrocarbon reserves will slow, as few state-run oil corporations have the equipment or the engineering expertise needed for this kind of work.

The evolution of Brazilian Petrobras and Hungarian MOL are good examples of different types of state capitalism (Otillar and McQuaid 2008; Butler 2011). At present, MOL is the second most valuable company in Central and Eastern Europe with revenue equal to roughly one fifth of Hungary's GDP.[13] Having examined the case MOL/OMV/Surgut, Butler (2011, p. 630) concluded that: "The geopolitical game that surrounds M&A in the energy market allows companies and states to promote tactics which will ensure their own security and potentially survival, but which at the same time have significant implications for other matters."

9.7 Conclusions

Oil-price volatility during the last 50 years is characterized by two crisis periods, Phase II and Phase IV, and two relatively stable periods, namely Phase I and Phase III. These periods are developed periodically as a result of interaction between oil prices and global energy geopolitics. During the last crisis period in Phase IV, two major geostrategic challenges emerged: (1) energy substitution, which is expected to

[13] https://molgroup.info/en/ [Accessed 22/07/2016].

decrease future demand for oil and gas, and (2) resource scarcity, which will result in declining conventional oil and gas production. These challenges will create dynamics that deeply influence the structure of oil and gas industry.

One major dynamic will be the intensification of competition between state-owned companies, which mainly control conventional oil and gas resources, and international and privately-owned companies, which develop unconventionals. The application of state capitalism to the oil and gas sector will increase as a policy response, especially in conventional oil and gas producing countries, such as OPEC countries and Russia. In countries such as the United States, where the oil and gas sector is driven by IOCs, efficiency improvements especially in the upstream sector for unconventionals will be a response to state capitalism.

Therefore, it can be concluded that the next challenge to confront the oil and gas sector is the rise of the state-intervention spirit.[14] Although it is considerably different from the wave of third-world nationalization that started during the early 1950s (Elm 1992), state intervention appears likely to affect the world petroleum industry for some more time. Due to geopolitical concerns, emerging markets like China consider state-directed firms as a sustainable model, and have redesigned capitalism to make it work better.

Similar governmental orientations towards state capitalism are also observed in the developed world. After being elected president of the United States, Donald Trump, who promotes new nationalism or neo-nationalism[15] by promising to "put America first" and "no longer surrender this country or its people to the false song of globalism," (The Economist 2016), selected Rex Tillerson, the former CEO of Exxon-Mobil, one of the largest oil companies in the world, as the Secretary of the State and Rick Perry, the former governor of Texas, the largest oil and gas producing state of the country, as the Secretary of Energy. These two assignments indicate that oil and gas will be a top priority of U.S. foreign policy.

These developments do not necessarily mean that free market will vanish from the oil and gas sectors, but it faces a less certain future as the state capitalism practices intensify (Bremmer 2010). In spite of interventionist policies, developed countries led by the United States will continue to represent free market while emerging countries, led by China and Russia, will support state capitalism. It is hard to assess the outcome of the competition between these two sides, yet it is certain that the "good old days" for the oil and gas sector are in the rear-view mirror, and the road ahead is ambiguous.

[14]It is also called as "'Resource nationalism' for the Petrobrass case (Otillar and McQuaid 2008, p. 262) and "governmentalization" to define the new type of nationalization of MOL (Butler 2011).

[15]New nationalism or neo-nationalism, which was first used by Gingrich and Banks (2006, p. 5) to define "the nationalism of the current phase of transnational and global development," which rose especially in Western Europe and United States after 2010. Some authors consider it as "nationalist resistance to global liberalism" (Stephens 2016).

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Geostrategy of the European Union in Energy

10

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Abstract

Among the many problems the European Union (EU) is facing, the energy question is an important one. Climate change forces the EU to reduce the use of fossil fuel. However, security of supply of energy relies heavily on the use of fossil fuel. This creates a dilemma for EU policy. The pollution caused by gas is less than the pollution of the other fossil fuels such as coal and oil. Therefore it seems reasonable that the first reduction will take place in the use of coal and oil and later on gas. This brings us to the next problem, namely that the EU is dependent on the gas import from politically instable countries. In this chapter, we will pay attention to the reduction of the use of fossil fuel as well as to the EU policy on gas import. We give an overview of the steps that the EU has taken and shall take to realize her goals for the coming years. To secure the availability of energy the EU will face a high gas dependency for quite some time. The gas market knows a number of instable countries, which makes energy a difficult political issue. The EU has to speak with one voice. In the EU every member country has a blocking vote, which weakens the position of the EU in the negotiations with non-EU gas suppliers. An alternative is the Energy Union, where the member countries have no blocking vote but takes their decisions based on the majority of the voting countries. To operate as one block is a better position than when EU-members negotiate bilaterally.

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10.1 Introduction

The EU has nowadays (2018) 28 members and every member has a blocking vote. Only in the case of unanimity, the EU takes a decision. In other words, every country can uphold every decision and can try to negotiate on advantages in return for her vote. The consequence is that the decision-making process takes a long time. The reaction of the EU on its threats is mostly too late and too weak, which is, in fact, an invitation to the counterparties to take serious steps against the EU. The former UK Prime minister Cameron promised his voters that there would be a referendum on the EU-membership of the UK. Cameron negotiated with the EU president Tusk to improve the conditions for the UK membership. He has got the right to refuse inhabitants of East European countries such as Poland, Romania, and Bulgaria to get access to the UK social funds. Nevertheless, the UK voters decided in 2016 to leave the EU ("Brexit"). The separation between the UK and the EU is a painful process that will take some time. The remaining 27 countries have all a blocking vote in the Brexit negotiation. Prime minister May of the UK started the official exit process in March 2017. The procedure contains a time frame of two years for the exit process. The fear is that during this period the internal EU struggle makes a strong EU position in negotiations with non-EU countries unlikely. Besides the Brexit, the EU is facing many threats such as an overload of refugees/immigrants, the political developments in Poland, and Energy supply security.

In other words, the Energy problem is not a stand-alone case but has to be understood and solved as a part of the total palette of issues in the EU. For example Poland with its deep-rooted distrust of Russia, relies heavily on coal as its primary source of energy, a natural resource that it can harvest in abundance without depending on Russia for its supply. Its imports of Russian gas amount to less than one-quarter of Germany's, which leads Europe in imports of Russian gas (see Table 10.2 in Sect. 10.3). In defiance of the EU's transition to more sustainable fuel sources, Poland's MEPs (member of European parliament) have voted consistently against the energy plans of the European Commission. Often they have stood alone in their opposition. Now, as the transition to a low-carbon economy becomes inevitable in Europe and throughout the industrialized world, Poland faces a prolonged and extremely expensive challenge to wean itself from its dependence on coal. The special position of Poland is not easily to solve. The Polish government takes political actions that are not in line with the democratic ideas of the EU (e.g., its controversial judicial reform). Poland can by using her blocking voting right obstruct every EU decision in reducing the CO_2 emissions. The position of Poland is also important due to its special relationship with Germany, a large supporter of the energy switch from fossil fuel to renewables.

The EU has formulated some goals on this switch. We will give an overview of the tasks that have already been done and the tasks EU has to do to realize the formulated goals.

Since 1987, the year the Brundtland Report was published, the awareness of the sustainable development and the global warming problem have been growing in the EU corridors of power. Greenhouse gas (GHG) emissions from human economic activities are held responsible for warming up the atmosphere. In the hope to set an example for the world the European Union has drawn up an ambitious masterplan for the reduction of its GHG emissions. The implementation of EU climate policy is still on the runway, with a target of 20% lower GHG emissions in 2020 compared to 1990. The decade 2020 to 2030 will see the take-off. The ambition is to have GHG emissions in 2030 at least 40% lower than in 1990. Passing in full flight in 2040 the target of 60% reduction, the landing at the destination of 80% to 95% reduction compared to the start will be in 2050 (European Commission 2014).

The goal of this chapter is twofold. Firstly, after the overview of the steps that already have been taken to reduce CO_2 pollution, we formulate the steps that have to be taken to realize the goals that EU has formulated. Secondly, we will look at the EU gas policy and strongly advise to support the Energy Union.

The originality of the work is that—as far as we know—this chapter is the first that pays attention to two mutually opposing goals, namely CO_2 reduction and energy independency of the EU. We believe that the EU can make progress on both goals by switching from oil and coal to gas (the least polluting fossil fuel) and renewables and by developing in the same time a coherent EU gas policy for all EU countries, using the Energy Union to avoid the blocking voting rights of individual EU countries.

In Sect. 10.2 we will look at the economic feasibility of the emission reduction targets of EU climate policy and the impact the policy will have on the position of fossil fuels in the EU. The EU energy policy to countries outside the EU will be presented in Sect. 10.3. In that section also the informal group called the Energy Union will be introduced. Section 10.4 concludes with our main arguments and takes a look ahead into the future.

10.2 EU Climate Policy and the Future of Fossil Fuels

EU climate policy is changing the rules of the game for the EU energy policy. Its traditional role is to make sure fossil fuels remain available for consumption in sufficient quantity at a reasonable price. The climate policy challenge is not how to secure fossil fuels but, to put it bluntly, how to get rid of them.

Over the period 1995 through 2014 GHG emissions in the EU-28 have decreased with a rate of change equal to the decrease of fossil fuel consumption (measured in toe: tons of oil-equivalent); both in the face of an increase in Gross Domestic Product (GDP). The development implies—see Table 10.1—that the GHG intensity of GDP, that is the quantity of emissions per euro of GDP, has fallen by about 38%. Moreover, so did the fossil fuel intensity of GDP with an exponential rate of decrease

Table 10.1 Indexes of GDP, fossil fuel consumption, GHG and CO_2 emissions 1995–2014

Indexes of	1995	2014	% change
Gross domestic product (GDP)	100	136.7	+ 36.7
GHG emissions	100	85.2	−14.8
Fossil fuel consumption	100	85.2	−14.8
GHG intensity of GDP	100	62.3	−37.7
Fossil fuel intensity of GDP	100	62.3	−37.7

Based on European Commission (2016, pp. 152, 161, 163, 41, 169)

Table 10.2 Biggest EU importers of Russian gas in billion of cubic meters

Country	2016
Germany	49.83
Italy	24.69
UK	17.91
France	11.47
Poland	11.07
Austria	6.08
Hungary	5.54
Czech Republic	4.54
Netherlands	4.22

Source: Gazprom company, Russia (http://www.gazpromexport.ru/en/)

of 2.5% per year. The figures illustrate the link between economic growth and consumption of fossil fuels has been broken and also that the fall in GHG emissions was tied very tightly to the diminution of fuel consumption. We expect no change in the relation and shall use as a guideline that every 1% reduction in GHG emissions requires 1% reduction in fossil fuel consumption.

The enormous saving in the use of fossil fuel for the production of GDP of 37.7% over 19 years can for only a minor part be ascribed to its substitution by renewable energy, given the modest rise of the share of renewable resources in total energy from 5% in 1995 to 13% in 2014. Increase in the use of bio-fuels is a further possibility, but we have no information on that option. Substitution of gas for coal and oil in power generation also has contributed: CO_2 emissions (measured in kilograms per gigajoule) are for natural gas about half the emissions of coal, while oil is just in between (IEA 2016, p. 150). The decrease in the share of industry in GDP and the larger share or the service sector, where fossil fuel intensity is lower, might also have played a role in reducing the consumption of fossil fuels, although that effect was largely compensated and possibly overcompensated by the strong growth of the very fossil fuel intensive service sector transport. Altogether the contribution of fuel substitution and sector changes to the lowering of the fossil fuel intensity of GDP cannot have been substantial.

Our preview that in 2030 fuel consumption will be 25% lower than in 2020 differs from the scenario the EU has in mind. To pick potential winners it finances carbon capture and storage (CCS) projects with several billion euro of subsidy. CCS is a technology to decrease carbon emissions in the atmosphere by trapping the CO_2 after combustion and transport it to a place where it can be stored in the ground. If CCS becomes available at sufficiently low costs, it opens the perspective of a carbon-free economy with the continuation of fossil fuel consumption, for example in electricity generation. Presently (2017), the technology still is in the demonstration stage and far too costly to be a competitive option. Our preview is based on the expectation that CCS will not succeed to make a breakthrough in the period 2020 to 2030. Whether GHG emissions in 2030 at a level 25% lower than the target for 2020 will be economically feasible depends crucially on the rate of fossil fuel saving technical progress. Assuming the decade will see an annual rate of GDP growth of 1.5% and an (exponential) decrease in fossil fuel consumption by 2.9%, an ongoing rise in the share the costs of energy consumption takes in GDP can only be prevented if the annual rate of fossil fuel saving technical progress is not below 4.4% (1.5% + 2.9%) per year over the whole decade.

Climate Policy in Two Sectors

GHG emissions are released by various sectors and the instruments applied to restrict emissions vary between the sectors. In this section, we focus on two major sectors: fossil fuel-intensive industry and road transport. The emissions of fuel-intensive industry, 45% of all GHG emissions in 2014, are contained with an economic instrument: The European Union Emission Trading System (EU ETS). In the transport sector, 20% of all GHG emissions in 2014, the command-and-control method of CO_2 emission standards for cars and vans is applied.

10.2.1 The EU-ETS System

10.2.1.1 The EU-ETS System: 2005–2020

The EU ETS was introduced in 2005. The scheme covers the GHG emissions of oil refineries, steel works and production of iron, aluminum, metals, cement, lime, glass, cardboard, acids and bulk chemicals. Included are also power and heat generation—think of electricity production transported through the public grid—and further commercial aviation for its flights within the EU. Next to carbon dioxide, two other GHG gases have been brought into the system. The three gases are measured in tons of CO_2 equivalent emissions. The target of EU ETS is to have in 2020 those emissions 21% lower than in 2005, the year the system started. For 2030 the target proposed by the European Commission in July 2015 is to have 43% lower GHG emissions than in 2005.

A firm operating under EU ETS has obligation to hand over to the supervising authority an allowance for every tonne of CO_2 equivalent emissions released by its installations. The number of allowances made available per year is equal to the target for the CO_2 equivalent emissions in that year for the whole group of firms. The allowances are made available by way of auction. Companies also adjust allowances to their emissions by buying or selling allowances on the secondary market. Since the supply of allowances is fixed the market price has the function to adjust the demand for allowances to available supply. Growth in GDP increases the consumption of fossil fuels; by that it raises the demand for allowances to cover the additional CO_2 emissions. So the allowance market price goes up. Fuel saving by companies lowers the demand for allowances, which leads to a fall in their market price. Given the supply of allowances the actual development of the market price in EU ETS depends on which of the two forces at the demand side has the upper hand.

Over the past years the allowance price in EU ETS has been falling from its early peak of 35 € in July 2008 to 7 € in Fall 2017 and in between even lower. Why is the price so low? The usual answer is that the emission target was too weak and as a consequence too many allowances have been handed out. Further the economic crisis and recession from 2008 to 2014 reduced output and in its trail the demand for allowances. That conventional explanation is incomplete. It overlooks that ongoing fuel saving technical progress has been reducing the demand for allowances from year to year since 2005 and must have been a major factor in depressing the market price. So, the conclusion must be that the low price of carbon allowances over the past six years reveals that GHG emissions are reduced at extremely low marginal cost thanks to technical progress in fossil fuel saving in the EU ETS sectors. Those costs are far below the expectations in 2005. That should not come as a total surprise. The phenomenon that as the reduction percentage goes up the average cost of emissions reduction actually goes down instead of up, as was forecasted, has been noted before (Krozer and Nentjes 2007).

A very widely shared view is that the price of carbon allowances is too low (e.g., The Economist 2013) The argument runs that such a low carbon price falls short as an incentive for research, development and introduction of low carbon technology. We don't detest the incentive effect has been weak. However, what the critics forget to mention is that over the past years fossil fuel saving technical progress has been going on, despite the low allowance price, because all the time the price of fossil fuels was and still is there as a strong economic incentive to save on costly fossil fuels. It has been working effectively in raising the efficiency of fossil fuels and in that way it has lowered the cost of reducing GHG emissions. Thanks to that development the sectors under the reign of EU ETS are going to meet the collective target of GHG emissions 21% lower in 2020 compared to 2005 easily by reducing their consumption of fossil fuels.

10.2.1.2 The EU-ETS System: 2020–2030

After having concluded that the sectors in EU ETS will meet the collective GHG reduction target for 2020 at low costs, we have to look forward to the target for 2030. One can have good hope that the rate of progress in fossil fuel efficiency will accelerate compared to the annual rate of 2.5% over the period 1995 through 2014, thanks to decrease in (a) the cost of production of solar electricity, (b) in the cost of storage of electricity in batteries and (c) in the cost of long-distance transport in electricity. The three developments have it in them to give in combination an enormous boost to the diffusion of electricity from renewable sources in the power sector, where it will be a substitute for fossil fuels.

The decrease in the cost of solar electricity is indeed spectacular. In the decade 2005 through 2014 the cost of power from large-scale photovoltaic installations in Germany fell from 0.40 €/kWh in 2005 to 0.09 € in 2014. It is expected that depending on annual sunshine the power cost by 2025 will be 0.04 € to 0.06 €/kWh (Fraunhofer ISE 2015). Cengis and Mamis (2015) conjecture that in the years between 2017 and 2024 the cost of PV panel production will have come down to grid parity around the world.

The cost of lithium-ion cells, the primary component of batteries, are coming down fast (The Economist 2017c). Grid operators are beginning to install lithium-ion battery packs for large-scale storage of electricity to smooth out the effects of intermittent power supplies from sun and wind and to manage peak power demand. Battery packs for small-scale storage are bought by companies and households that want independence from the grid or to store the electricity they produce and sell into the grid at the most lucrative time.

The variability of electricity supply from sun and wind as well as its costs are also diminished by the penetration of new technology for the long-distance transport of electricity. Large-scale generation of electricity from renewables often requires high voltage transport over long distances. When the grid employs the usual alternate current (AC) it leads to large loss of electricity on its route to consumers. That is avoided by investment in a special cable for direct current, the so-called long–distance ultra-high-voltage direct-current (UHVDC) connector. China is by far the leader in applying the technology (The Economist 2017a). In Europe, the first steps are set by 50Hertz, a German grid operator. A new UHVDC-line will ship electricity produced in wind parks in northeast Germany to Meitingen in Bavaria where it will replace the power from south German nuclear plants. Boris Schucht, 50Hertz's boss, foresees in the not so far future an infrastructure of UHVDC-lines that will bring electricity generated in large windmill parks to Scandinavian hydroelectric plants to pump water uphill in the storage reservoirs and transform intermittent supply in base-load electricity supply (The Economist 2017a).

The combined technical progress in solar panels, batteries and long-distance electricity transport holds for the decade 2021 through 2030 the promise of a great breakthrough in the production, transport and consumption of electricity based on renewables at costs equal to and lower than energy from fossil fuels. As the scenario unfolds it will release a formidable supply of carbon allowances from electricity companies within the power sector that will become available for companies in other EU ETS sectors. The supply will depress the market price for carbon allowances and keep the cost low for companies in EU ETS that cannot do without fossil fuels. Further the development towards steadiness in the supply of electricity from renewable resources will gradually wipe out the notion that the increasing share of renewables leads to an increasing need for base-load electricity, generated by nuclear power installations.

10.2.2 Emission Standards and Energy Breakthrough in Road Transport

The share of the transport sector in total GHG emissions of the EU is around 22%; more than two-thirds of it comes from road transport. The key instrument to curb CO_2 emitted in road transport is command-and-control in the form of mandatory maximum CO_2 emissions for new cars and vans in various classes, with differentiation of the emissions standards according to mass of the vehicle. The maxima set for 2021 imply a 40% reduction in CO_2 emissions compared with the fleet average in 2007. Up to now (2017) little has been done to cut the GHG emissions from heavy-duty vehicles. Transport is the only major sector where in 2014 total GHG emissions were higher than in 1990. The increase of emissions by 20% was caused by the tremendous growth in the volume of road transport, which largely undid the effect of more strict standards for CO_2 emissions of new cars.

The mandatory standards for new cars and vans are based on what is deemed to be feasible in the technology of the internal combustion engine. They do not command revolution; yet that revolution has already started: the switch-over to the battery-charged electric vehicle (EV). Patel et al. (2017) project EVs may be competitive by the mid-twenties and by the mid-thirties make up between 27% and 37% of new car sales.

The success of the EV is above all the fruit of the miraculous development of the lithium-ion battery. Battery costs per kWh have come down immensely while battery energy density (watt-hours compared to energy per liter petrol) increased progressively. The fear that an electric car will run out of power before reaching a charging point is in remission. EV drivers with off-street parking and a socket to plug in can charge at home; 90% of charging is done in this way. Investments in public charging points have in rich countries just about kept pace with the growth of EVs. The Economist (2017d) sees it as unlikely that a lack of infrastructure will hold back the spread of EVs.

We conclude that by 2030 the electrical car will be well established, thanks to market forces. Regulation will follow its lead by basing new emission standards on the emissions of a car propelled by electricity. Calculations for the U.S. find that existing electric cars reduce carbon emissions by 54% compared with petrol powered cars (The Economist 2017b). It illustrates the superior fuel efficiency of electricity from central power stations, compared to burning oil in separate engines. This is only a halfway station. By 2030 good progress will have been made in making electric cars cleaner, thanks to the technical progress in production, transport and storage of electricity from renewables, on which Sect. 10.2.1 reported.

In 2015 almost half of total oil consumption in the EU was in road transport. The Economist (2017b) mentions that Royal Dutch Shell foresees global demand for oil will reach its peak between 2025 and 2030. It inspires the journal to unfold a scenario in which producers with vast reserves that can be tapped cheaply will pump what they can before it is too late, while in new, high-cost areas investment will come to a stand-still. However, the scenario overlooks that in 2015 cars counted for one third of the EU's total oil consumption (own calculations based on Eurostat). Major oil-slurping, growing sub-sectors in transport, such as heavy duty vehicles, on and off the road, and also shipping and aviation, will only slowly get loose from their addiction to fossil oil. Together with the demand for crude oil from petro-chemical industry that will keep the oil industry alive and reasonably well for the next two decades or more, unless new developments succeed to make bio-fuels a substitute that in costs is competitive with fossil oil.

10.2.3 Concluding Remarks on Climate Policy and Energy

From the information available in Fall 2017, it is evident that the climate policy of the European Union will be successful in bringing down its GHG emissions by 20% in 2020 compared to 1990. This has been done by way of a proportional reduction in the consumption of fossil fuel enabled by fuel-saving technical progress. Companies have an incentive to make the efforts that generate such improvements in energy technology because they have an interest in lowering the cost of fuel input in their production process and also in their products, such as cars. The major role of fuel-saving technical progress explains why the cost of energy has remained low despite the growth in GDP.

The target of EU climate policy for 2030 is 25% lower GHG emissions than in 2020. We foresee for that period in the sectors fuel-intensive industry and road transport a development that is basically similar to the experience up to 2017: steady reduction of GHG emissions, brought about by lower fuel consumption, thanks to fuel-saving technical progress. The difference between the two periods will be that the future rate of progress in fuel saving has to be twice as high as before to prevent a steady rise in the costs of energy consumption. There is no guarantee that such an acceleration will occur, but it is within sight thanks to the breakthroughs in the production of electricity from renewables, the penetration of that new technology and its further improvement during the decade in the process of learning by doing. It is not difficult to see that the technical progress will also transform the use of energy in other sectors, such as households.

10.3 Current State of Energy Policy in the EU

As we have seen in the earlier sections, the EU has a large focus on CO_2 reduction by switching from fossil fuel to renewables. However, due to the unexpectedness of wind and solar energy, the energy security is at stake. The pollution of gas is less than the pollution of oil and coal. Therefore, although we have the switch from fossil fuel to renewables, the gas production and consumption will continue on a certain level. In this section we will foremost look at the EU gas market and will pay attention to: gas supply in the EU, Energy dependency challenges and the Energy Union.

10.3.1 Gas Supply in the EU

The EU is not only importing gas, but also has its own gas industry. Starting the sixties of the last century Groningen (The Netherlands) produced gas and The Netherlands has a well developed gas network. Nearly every household in the Netherlands has a link with the gas network. However, the production of gas has also its disadvantages. Groningen is facing earthquakes caused by the gas production. Buildings are becoming damaged by the earthquakes, and the population of Groningen wants that the gas production is decreasing substantially. Some hardliners wish a total stop in production in Groningen. Furthermore, we see that the gas production in North-West Europe is declining. The United Kingdom (UK) was untill 2006 a (net) gas exporting country, but switched to a gas importing country. Skea et al. (2012) write that during cold days UK are facing potential shortfalls. The switch from a gas exporting to a gas importing country is less abrupt in The Netherlands. The gas production in The Netherlands will decrease gradually, and the developed gas network will be used for gas imports from other countries. Schipperus and Mulder (2015) write that the Netherlands choose for the alternative of a gas roundabout. It will import gas and due to the well-developed gas network, it can easily distribute this to other countries. The own gas production in The Netherlands will serve as a swinging supplier.

One of the potential newcomers is the eastern part of the Mediterranean. There seems to be a large potential for future gas production. Countries like Cyprus, Egypt and Israel, which are not traditional gas suppliers, have offshore gas fields. The main question is: Can these countries deliver the gas in the competitive European market? [see also the chapter of Karbuz (2018) in this book].

First of all, the market suffers under a supply that is higher than the demand and it is expected that also in the coming years this imbalance will not disappear. Second, the Eastern Mediterranean knows a high political risk. North Cyprus is recognized only by Turkey as an independent country; Cyprus suffered a couple of years ago under a bank crisis and her strong link with Russia is not a recommendation; Egypt has internal political problems with the Muslim Brotherhood and the relationship between Israel and its neighboring countries is not optimal. The opportunities of the Eastern Mediterranean on the European gas market are mixed. Its gas can be a good alternative for the Russian gas. However, the high political risk is an important disadvantage.

Energy policy belongs to the so-called shared competences of the EU and its shape is therefore influenced by all Member States and the EU itself. EU institutions mainly as coordinate, but there are also areas in which the EU Council and the European Parliament (EP) can approve legally binding legislation for member states, based on the European Commission proposal. These include the necessary measures, especially in the fiscal area, to help achieve energy policy objectives set out in Article 194 of the Lisbon Treaty signed in 2009. Conversely, setting the energy mix, choice of energy suppliers and deciding on the direction of energy policy the Lisbon Treaty leaves power to national governments, which allows different approaches of individual Member States. France is supplied mostly by nuclear power, Germany promotes the renewable energy and Poland is largely remained dependent on coal.

The current EU energy policy is based on the Green Paper "A European Strategy for Sustainable, Competitive and Secure Energy" from 2006 in which the European Commission has set out six key areas on which to focus. These are: the completion of the internal market in electricity and gas, the internal energy market that guarantees security of supply; solidarity between Member States; security and competitiveness of energy supply (=diversification of energy sources); integrated approach to tackling climate change, promoting innovation and technology and a common external energy policy.

In order to realize this, in 2007 the third liberalization package of legislation on the internal energy market was approved, aimed at ensuring effective competition, creating favorable conditions for investment and diversity of supply security. The EU concern relates primarily to natural gas, due to the several Member States depending on a single supplier—Russia. In January 2014, the European Commission introduced a new draft package of energy and climate policy objectives until the year 2030. It is aimed at bridging problems with energy sector over-regulation, which goes to the detriment of the competitiveness of European industry.

The EU remains acutely aware of its vulnerability to disruptions of its energy supplies. Commercial disputes between Russia and Ukraine in 2006 and 2009 severely reduced the flow of natural gas to the rest of Europe, while accidents, natural disasters and concerns related to climate change continually reveal the precarious foundations on which Europe balances its industrial and social prosperity.

To reduce this vulnerability, the Commission adopted measures in 2008 under its Energy Security and Solidarity Action Plan to reinforce its relationships with supplier nations, enhance the security of transit channels and accelerate development of energy-related infrastructure, especially pipelines. The effectiveness of this plan depends on solidarity between the EU's member states and their accommodation of diversity in their sources and suppliers of energy, especially natural gas. To this end, EU policy has focused on interconnection with Baltic countries, construction of a southern corridor to transport gas from the Caspian Sea and the Middle East, construction of liquid natural gas (LNG) terminals to reduce reliance on gas shipments from Iran, the Middle East and sub-Saharan Africa to Mediterranean ports, and a unified network from north to south for the transmission of electricity and gas.

EU may include an increased import of natural gas from above-mentioned regions to 100.5 billion cubic meter (bcm) building the gas pipeline Galsi (between Algeria and Italy) and the opening of the gas pipeline MedGaz (between Algeria-Spain), etcetera. For the EU is also important the Trans-Sahara gas pipeline that should connect Nigeria and Algeria. However, the project has been delayed by political and security problems. With the advancement in technology that now allows transport of natural gas to large distances, the EU gets a new source of energy, liquefied natural gas, which may come from Australia or USA.

The European Commission published in January 2014 a report according to which energy prices in the EU are much higher than elsewhere in the world. The price of electricity in the EU is two times higher than in the USA, and the price of natural gas is even 3–4 times higher compared to prices in the USA or Russia (Polak 2014). EU gets into a comparative disadvantage when it wants to lure energy-demanding investors. The fault is not only a high dependence on energy supplies from abroad (mainly from Norway, Nigeria, Qatar, Algeria and Russia), but also ambitious commitments made e.g., within the energy-climate package of Europe 2020, Europe's growth strategy with ambitious binding targets in energy and climate protection.

While the development of shale gas may help in lowering energy prices, European industries continue to demand high levels of energy for their operations. With this in mind, the European Commission has proposed the relaxation of binding commitments by member states to reduce CO_2 emissions by 2030. Instead, the Commission proposes that each country achieve emission reductions according to its individual capabilities, either through increasing the role of renewable energy or through an emphasis on an efficient core source while alternative sources can be developed.

Primary the EU-28 energy production in 2014 was spread across a range of different energy sources, the most important of which in terms of the size of its contribution was nuclear energy (28.7% of the total); the significance of nuclear fuel was particularly high in France, Belgium and Slovakia where it accounted for more than half of the national production of primary energy. More than one fifth of the EU-28's total production of primary energy was accounted for by renewable energy sources (25.5%) and solid fuels (19.4%, largely coal), while the share for natural gas was somewhat lower (15.2%); crude oil (9.1%) made up the remainder of the total (Eurostat, on line data codes: nrg_100a and NRG_107a).

On 20–21 March 2014, the European Council discussed the EU energy security. It concluded that "efforts to reduce Europe's high gas energy dependency rates should be intensified, especially for the most dependent Member States".[1] Progress made since the 2006 and 2009 energy supply crises in creating a common energy market and implementing mechanisms that would ensure the security of supply has been insufficient. The EU remains vulnerable to political pressure due to its high dependency on oil and gas imports. Its room for maneuver vis-à-vis Russia is limited, and its efforts in the current crisis have been less effective as a result.

10.3.2 Energy Dependency Challenges

This text proposes a set of measures that address the EU's energy dependency challenges. Its implementation could lead to the creation of a genuine "Energy Union" in Europe. All the measures and instruments should be introduced based on the Treaties with full respect for the current balance of competencies between the

[1] http://gastechinsights.com/article/eu-seeks-strategy-to-reduce-gas-dependency

EU institutions and the Member States and the sovereign right of Member States to determine their energy mix.

The Lisbon Treaty has created a legal basis for EU energy policy with full respect to the Member States' right to exploit and choose their energy sources and structure their energy supply. The EU has already undertaken actions to ensure: the creation of a functioning common energy market; the security of energy supply in the EU; the promotion of energy efficiency; the development of new and renewable energy sources; the promotion of the interconnection of energy networks; and the strengthening of the external dimension of EU energy policy. Now is the time for the EU to accelerate its activity and fully exploit its current treaty competences to build an "Energy Union".[2]

10.3.2.1 First Pillar: Infrastructure

Removing energy islands and bottlenecks from the infrastructure map of Europe remains an urgent challenge. Gas and oil imports dependency remains an unaddressed challenge for the EU. It includes rediscussing the importance and needs of the oil sector in order to decrease oil dependency and address lack of diversification capabilities of the EU refining sector. The EU needs to find a way for including the oil sector in its financial support policies i.a. Via support for oil infrastructure and storage capacities and developing new technologies for refining sector to mitigate the dependency from single supply sources.

10.3.2.2 Second Pillar: Solidarity Mechanisms

Faced with a crisis, the EU should make use of its aggregated power. That should include developing preventive planning and emergency responses to potential supply disruption scenarios. In the event of a crisis, no Member State should be left alone.

The security of supply regulation should be revised in order to enable the development of EU-level response mechanisms for crisis situations: EU risk assessment; EU preventive plan; EU emergency plan. The system should be built upon crisis and management capacities of the European Commission; optimized use of existing and planned infrastructure, including gas storage facilities; the full advantage of the specificities and potential of each Member State's energy system. Combined, these elements should allow for the creation of a system that would ensure a flexible and fast reaction to any events that could result in supply disruption. Before a revision of the SoS (security of supply) Regulation, the Commission would be invited to prepare an EU Risk Assessment, taking into account new geopolitical risks which could lead to disruption of gas transit through Ukraine.

[2]Huge thanks to Mr. Szymon Polak, First Secretary, Energy Section, Permanent Representation of the Republic of Poland to the EU, for his kind comments and ideas.

10.3.2.3 Third Pillar: Strengthen the Bargaining Power of Member States and the EU Vis-à-Vis External Suppliers

Member States should reinforce their position during negotiations with third countries by acting under the" umbrella" of the EU and making use of the internal market and economy of scale benefits. A creation of demand aggregation mechanism for external gas supplies at the EU or at the regional level could be an efficient tool to optimize the bargaining position of the major wholesale gas recipients on the EU market and could form an effective remedy to the segmentation of national markets and inequality in terms of gas pricing among the Member States. This could take the form of a collective purchasing mechanism, and the Commission should be invited to analyze its potential structure and impacts on the development of the functioning internal gas market and to ensure security of supplies. Since there are several models of collective purchasing mechanisms, further work should be done to examine the best market-based options applicable for the EU regions and suppliers concerned.

10.3.2.4 Fourth Pillar: Development of Indigenous Energy Sources in the EU

European dependence on oil imports has grown from 76% in 2000 to 90% in 2014. The EU spends some 215 € billion on oil imports, over five times as much as on gas imports (40 € billion). Russia is the biggest supplier: dependence on Russia has grown from 22% in 2001 to 30% in 2015.[3] The development of utilization of indigenous resources should be treated as an investment in the EU energy market that will stimulate the economy. It could shift the European capital flows from external suppliers to the European energy producers. Hydrocarbons help to address energy dependency challenges cost-effectively. No energy source that might contribute to the EU's energy security should be discriminated against. Conventional fossil fuels should be acknowledged as a vital element of EU energy security. The EU should also support those Member States who decided to exploit their unconventional gas and oil resources by: emphasizing the fundamental importance of unconventional resources for the EU's security of supply and competitiveness; confirming that current EU legislation is adequate and sufficient for the safe exploitation of unconventional resources so that there is no need for new legislative proposals in this respect; stressing that drafting specific national regulations on environmental and investment conditions (that means for the extraction of shale gas) lies within the competence of Member States; supporting the integration of shale gas infrastructure with the gas networks of Member States; supporting the development of environmentally safe unconventional hydrocarbon technologies, sharing best practices and raising public awareness.

[3] http://energypost.eu/europe-increasingly-dependent-oil-imports-russia/

10.3.2.5 Fifth Pillar: Diversification of Energy Supply to the EU: Gas and Oil in Particular

The better the energy infrastructure in the EU and the more integrated the EU energy market, the easier it will be to attract alternative external suppliers. Energy infrastructure development and EU market integration will attract alternative external energy suppliers. We should, therefore, strive to enhance EU cooperation with current alternative external suppliers and invite new ones for oil and gas deliveries.

The global LNG market is of particular potential in this regard, especially since the shale revolution in North America opened access to significant shale gas and tight oil reserves. At the same time, the growing interest of the North American gas sector to invest in gas-export infrastructure, namely LNG, will soon allow for a significant increase of LNG shipments. The EU should, therefore, enhance its cooperation with Canada and call for opening US gas exports to the EU. This would be beneficial both to the EU's gas consumers and to US gas exporters which would gain access to Europe's integrating gas market. Australia is also a prospective partner in that regard. We should continue work on the Southern Gas Corridor, enhancing cooperation with new suppliers from the Caspian Region as well as the Mediterranean, such as Azerbaijan, Turkmenistan, Iraq or Israel where new investments in the exploitation of energy reserves are being launched.

In order to diversify oil supplies and attract new suppliers (e.g., from Kazakhstan or Azerbaijan) the EU should increase the scope of financial support to new oil-import infrastructure and support investment in the refinery sector allowing for efficient oil processing regardless of the type of oil delivered.

10.3.2.6 Sixth Pillar: Reinforcing the Energy Community

The path to EU energy security leads through a stable and secure neighborhood. Safe neighbors mean a safer EU.

Support of the EU for the Energy Community should be streamlined especially towards Ukraine and Moldova to enable the implementation and application of binding legislation under the Energy Community Treaty. The EU should provide technical support with regards to creating independent energy-market regulators in these countries.

Significant progress should be made as regards the realization of missing projects that will connect the Energy Community countries, in particular, Ukraine and Moldova, with the EU internal market. These include:

- Gas reverse-flow on the Brotherhood pipeline;
- Upgrading, developing and technical integration of electricity and gas grids of bordering the Member States and upgrading interconnectors between EU and Energy Community countries.

EU support for the modernization of Ukraine's gas transit system should be accompanied by progress in the implementation of relevant binding legislation under the Energy Community Treaty (pointing to the need for an EU task force).

A long-term strategy for developing indigenous energy sources and increasing energy efficiency should be further promoted in the Energy Community countries.

Technical support on the part of the EU (and with the direct participation of the Commission) should be considered for the Energy Community countries (on request) in their negotiations with energy suppliers from outside the EU. Legal capacities of the Energy Community Secretariat need to be strengthened to provide for the swift and efficient implementation of the EU energy acquis in the Energy Community countries.

EU's Energy Imports from Russia

The EU gas dependency of Russia is large but not equally divided among the EU countries. Table 10.2 contains the biggest EU importers from Russian gas in 2016.

The EU currently imports more than 60% of its natural gas. By 2030, this figure is expected to rise to 80% for gas. While the EU has access to other suppliers besides Russia, some individual states rely more heavily than others on Russian sources. Finland, Slovakia, Baltic states and Bulgaria still depend on Russia for almost 100% of their gas consumption. Greece and the Czech Republic import 70% of their gas from Russia. However, in Germany, Austria, and Poland, Russian gas accounts for less than half of their annual consumption. Belgium and the Netherlands import only 5% of their gas from Russia, while Denmark, Sweden and Cyprus import no gas from Russia at all.

Obviously, an increase in imports of gas from Russia would have a different impact in different countries. In Belgium, it would merely diversify its sources of supply; in the Czech Republic, it would reinforce the country's dependence on Russia for its energy requirements.

It is also important to keep in mind that dependence among European countries on Russian gas can be alleviated by Russia's dependence on Europe as a consumer of its supplies. Of Russia's total gas exports, more than 80% goes to the EU. Russia depends on oil and gas to generate about half of its total budgetary revenue. Regardless of President Vladimir Putin's geo-political ambitions, Moscow cannot afford to jeopardize such a critical source of revenue.

In April 2014 Polish Prime Minister (now President of the European Council) Donald Tusk published an essential article in the Financial Times of London.[4] In the article, Tusk urges Europe to re-create an energy union as a defense against what he calls Russian energy blackmail. As proposed by the Polish Prime Minister, the common energy policy abandons many of the ideas that informed a suggested European Union energy union in 2007 and 2008. In their place, it accommodates the current energy interests of Central and Eastern European EU members, including Poland, the largest of these countries. In an apparent response to the conflict in Ukraine, Tusk holds that Europe has become excessively dependent on Russian energy supplies. "A dominant supplier has the power to raise prices and reduce supply," he says. "The way to correct this market distortion is simple. Europe should

[4] www.ft.com/intl/cms/s/0/91508464-c661-11e3-ba0e-00144feabdc0.html%20axzz38qBBIR6P

confront Russia's monopolistic position with a single European body charged with buying its gas."

Using "the stand-off over Ukraine" as a starting point, Tusk's proposal for an energy union protects the interests of Eastern EU member states and initiates a diplomatic energy battle against Germany, whose energy policy, called Energiewende, seems to remain inextricably linked to a direct supply of Russian gas (Polak 2014).

Referring to the European Coal and Steel Community, formed in 1951, Tusk says an energy union would address similar challenges that reflect the fundamental principles of the European project. "Whether in coal, steel, uranium, credit or gas, the principal idea of the EU has always been to bring Europe together, deepening our security and establishing fair rules where the free market is lacking," he says. "An energy union, too, would be based on solidarity and common economic interests."

In pursuit of his proposal, Tusk sets out six principles:

1. The EU must create a mechanism for jointly negotiating energy contracts with Russia.
2. Mechanisms guaranteeing solidarity among member states should be strengthened in case energy supplies are cut off.
3. The EU should support the construction of storage capacity and gas links with the highest level of co-financing from Brussels: 75%.
4. Europe should make full use of available fossil fuels, including coal and shale gas. "We need to fight for a cleaner planet," Tusk says, "but we must have safe access to energy resources and jobs to finance it."
5. The EU must reach beyond its boundaries for partners such as the U.S. and Australia, which can supply the European market with liquefied natural gas.
6. The EU strengthens energy security of the eight countries on its eastern borders and reduces its dependence on Russian gas by reinforcing the existing Energy Community Treaty, created in 2005.

10.3.3 Energy Union

In outlining his proposal, Tusk has incorporated many of the ideas that were discussed after Russia shut down its gas shipments to the EU in 2009. Since then, EU's natural-gas operations have undergone some fundamental changes. The European Commission forced gas companies to unbundle their supply, transmission and storage operations and to guarantee non-discriminatory access by independent suppliers to the transmission network through virtual trading points.

With gas markets opened to competition, prices became subject to volatility and speculation, and trading of short-term contracts intensified. Conventional long-term contracts based on prices derived from the cost of producing and transporting petroleum products became far less attractive. However, Russia's dominant gas supplier, Gazprom, refuses to sell its gas on the open market and maintains long-term contracts with Europe's leading gas companies such as Wintershall in Germany and ENI in Italy (Polak 2015).

In this context, the economic logic of Tusk's proposal for a common European platform to purchase gas from Russia becomes clear. One large customer can negotiate much better terms with a supplier than dozens of small customers on their own. A single entity formed under an energy union would balance the scale of Gazprom so that the two sides could negotiate on equal footing. Once this occurs, Europe could begin to break the Russian monopoly on gas supplies and open its energy marketplace to free competition.

Like other proposals for a unified European energy policy, Tusk's does not acknowledge the role of private companies in the energy marketplace but instead focuses on the need for government action. Nevertheless, Tusk's proposal would affect the execution of existing long-term contracts between European importers and Gazprom. Initially, it would remove from existing bilateral contracts clauses that limit market principles. It would also establish a model for all future contracts, ultimately negotiated by the European Commission on behalf of EU Member States. In calling for more transparent long-term contracts in a single-market EU, Tusk's proposal would only enhance the competitive environment for energy supplies, enhance the transparency of long-term contracts and eliminate vertical integration to create infrastructure linkages.

The implementation of his proposal is a much more complicated matter. Tusk compares his energy union with Euratom, which acts for all EU nations in purchasing uranium for European nuclear power plants, assists in negotiations with suppliers and ensures that customers have equal access to supplies while adhering to the principles of energy security. However, centralized purchasing of natural gas presents a much more complicated process. Compared to uranium, quantifying future demand for gas requires much more complex calculations, and security of supply in an open marketplace depends on much greater market flexibility.

This is not to dismiss Tuck's proposal. However, a central purchasing mechanism under the supervision of the European Commission can succeed only under the following conditions:

- The mechanism works in conjunction with free-market trading at virtual trading points;
- The mechanism applies only to long-term contracts, and
- It would not interfere with the freedom of private European companies to compete for market share.

Austvik (2016) discusses the debates about the Energy Union and looks at the different positions of Central and Eastern European countries (CEEC) and the Western European countries. The CEEC were under the Soviet Union regime and became more gas dependent from Russia than the Western European countries. In the last decades of the twentieth century, the Soviet Union exported gas by pipelines to the CEEC countries, sometimes against a lower price than the market price, and also to the Western European countries against market prices.

Austvik (2016) refers to Mr. Perle, assistant secretary of defense in the Reagan administration, who mentioned in 1982 three reasons for the Russian gas export policy to (Western) Europe. Firstly, the Russian gas export to Western Europe was a good tool to receive hard currencies. Secondly, an economic link between Europe and the Soviet Union was created. Thirdly, the European gas dependency of the Soviet Union gives the Soviet Union a tool for political pressure. Later a fourth reason was added, namely that the material for the gas pipeline infrastructure came from Western Europe, but could also be used for military purposes.

After the breakup of the Soviet Union in 1991, the gas was now transported through independent countries to Western Europe. Some of these transit countries - such as Ukraine - had no longer a good relationship with Russia, the successor of the Soviet Union. The gas delivery from Russia through Ukraine to Western Europe was sometimes stopped due to disagreement about prices (but unofficially also due to political reasons).

Austvik (2016) mentions some hurdles for a joint EU policy.

1. There are heterogeneous preferences about what the EU is and normatively should be. Spain negotiates with Morocco about energy; not the EU and Morocco.
2. The market between East and West, but also within the West differs.
3. Economic developments differ between East and West and contribute in creating different preferences in the field of the environment and climate change.
4. Eastern and Western European relations to Russia in general and for Russian gas, in particular, are formed in a somewhat different sum of hard and soft forces, path-dependent relationships and constraints.
5. The financing of extended infrastructure and better interconnectedness is based on the premise of a financially strong EU, a greater degree of supranationality, and more extensive use of the "Community Method".

Misik (2017) comments the article of Austvik (2016) and argues that CEEC is no longer a homogeneous group of countries and he is less pessimistic about a European answer on Russia. Misik (2015) writes that the countries that joined the European Union after 2004 after in general highly dependent on Russian energy supplies and some of them (Slovakia and Bulgaria) have no or only limited alternative suppliers.

10.4 Conclusion

In this chapter, we dealt with two energy questions of the EU, namely the EU climate policy and the Energy Union to secure the availability of energy. The EU climate policy has direct consequences for the EU energy policy, since the aim of emissions of greenhouse gases in 2050 at a level that is 80% to 95% lower than in 1990 cannot be achieved without a reduction in the consumption of fossil fuels of about the same percentage. The transmission to a carbon-free world will bring an end to the economic era based on energy from fossil fuels.

Historically the ongoing decrease in the fossil fuel intensity of production has come from technical progress driven by the incentive to save on costly energy. In a growing EU economy an annual rate of increase of 2.5%, as was realized over the years 1995 through 2014, will be insufficient to achieve the planned reductions in GHG emissions without continuously rising cost for society. Looking forward to the decade 2020 to 2030 we foresee such an acceleration in the rate of fossil fuel saving technical progress thank to four breakthroughs: spectacular decreases in the costs of production of solar electricity, storage of electricity in batteries, long-distance transport of electricity and the electric car evolution. The four developments have it in them to give in combination an enormous boost to the diffusion of electricity from renewable sources as a substitute for all three fossil fuels and even for nuclear energy.

For the decade between 2020 and 2030, the scenario of decreasing fossil fuel consumption by 25% in 2030 compared to 2020 will, in particular, hit the consumption and production of coal, which is the most carbon-intensive of the fossil fuels. The regions within the EU that are economically highly dependent on coal industry are looking forward to substantial times of economic adjustment. The breakthrough of the electric car will lower the demand for oil, but heavy-load road transport, shipping, and aviation will keep oil consumption going, albeit at a lower level. Gas, with the lowest carbon intensity and a substitute for coal in electricity generation, can function as a transition fuel, which may slow-down its fall in consumption in the period between 2020 and 2030.

In 2013 the EU emitted 10.8% of global CO_2 emissions; third in rank, after China (27.4%) and the U.S (15.7%) (European Commission 2016, p. 18). In an uncertain world, the wise strategy is to look for economically and politically powerful states as international partners that intend to go into the same direction as EU. Implementation of the Paris Agreement in the form of international coordination of national policies to reduce GHG emissions helps to create more economic certainty and stability in political relations. In the context of such cooperation, information can be exchanged and coordination tried out of such difficult issues as the shrinkage in the international consumption, imports and exports of fossil fuels.

Just as they did after the Word War II, European leaders wonder whether they should assess energy security collectively as members of the EU or individually as autonomous nation states. While the debate continues, a European Energy Union cannot function effectively as long as individual nations pursue their sovereign energy strategies. Germany's unilateral pursuit of an energy policy based on renewable resources backed up by gas-powered electrical plants, conflicts with and disrupts the stability of energy strategies pursued in neighboring countries. Likewise, the special relationship between German energy companies and their Russian supplier works to their benefit and to the detriment of other European countries in their relationships with Gazprom.

Russia remains the primary supplier of natural gas to the European Union, and natural gas continues to play an important role in relations between the EU and the Russian Federation. The EU's fundamental energy-related challenge is to restrict its dependence on Russia and try to geographically diversify energy sources. To this end, Europe must better align its gas pipeline network and invest more heavily in the capacity of port terminals to accommodate imports of LNG (Polak 2017).

To achieve its objectives, Europe must constantly speak with a single voice to denounce onerous long-term contracts for gas imports from Russia and to gain a stronger bargaining position. As part of its diversification strategy, Europe must also invest in an Iran-Europe Pipeline to bring gas to Europe from Central Asia and Iran.

Russia currently faces threats on multiple fronts to its role as Europe's dominant supplier of natural gas. If the EU can exploit Russia's vulnerabilities to its advantage while putting in place the contracts and infrastructure to import gas from alternative sources, it can increase its energy security on more competitive terms. To this end, European countries must be willing to set aside their interests for the sake of their collective long-term benefit.[5]

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[5]More on: https://www.foreignaffairs.com/authors/petr-polak

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11 Geostrategic Importance of Energy Trade and Transit and a New Transit Regime Under the International Energy Charter

Volkan Özdemir

Abstract

The energy transit constitutes one of the critical components of energy value chain, since it frequently involves transport and access issues as robust energy trade can only take place with access to a well-connected and well-managed transmission network. Issues such as feasibility of investments, non-discriminatory access to infrastructure and related legal regulations have elevated energy transit security to top of the energy security agenda. A search for reliable transit of energy goes parallel with multi-dimensional, evolving and administrative nature of energy security as well as with geostrategic calculations of the leading actors. Currently there is no internationally binding agreement which regulates the energy transit since transit provisions of World Trade Organization and Energy Charter Treaty are vogue. An international transit protocol has been discussed under the Energy Charter Treaty for decades, but the process has not reached an agreement. Various regional markets such as EU market have developed their own energy regulations and thus most of the transit issues within the union were solved. Nevertheless, there is still lack of an energy transit regulation in wider Eurasia (specifically from China to Turkey including Caspian states). In that sense, a more modest form of transit regime could be applicable for a specific region rather than an international one. In this paper, the geostrategic importance of energy transit and possibility of a new regime under the International Energy Charter will be discussed with a specific reference to energy market developments and new geopolitical realities in Eurasia where such kind of a regional transit community could be achieved.

Keywords

Geopolitics of energy · Energy transit · International energy charter · Eurasia

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11.1 Introduction

The importance of energy resources, as the basis for economies to function, have always been underlined by academics and practitioners. However, securely transmitting those resources to the markets and importance of this process have only recently become one of the main aspects of energy studies. The energy transit, which frequently is involved with transport and access issues, constitutes one of the critical components of the energy supply chain. Issues such as feasibility of investments for transportation, non-discriminatory access to infrastructure and related regulations have elevated energy transit security to top of the energy security agenda. With increasing interdependence, suppliers and consumers alike have become even more concerned about transit security. Although the concept of energy security has different meanings for energy exporting, importing and transit countries, energy transit security is fundamentally important to all actors as a whole.

Energy importing countries are at first very much interested in uninterrupted flow of energy products to their borders for the well-functioning of their national economies. Once they have made an investment and have signed a contract, the importers take on a risk and they are mainly concerned over regulations that provide stability. On the other hand, energy exporting countries and their enterprises pay more attention to stable markets as the source to reach foreign capital and they are highly interested in minimizing the transit risks. The most striking difference in defining the energy security is found between energy importers and exporters, resulting from the emphasis on security of supply for the former and security of demand for the latter. Regardless of actors' interests, what makes the transit security important among others is that all involved countries whether exporting, importing, or transit, should give a special attention to the security of uninterrupted flow of energy at an international level.

In this paper, at first fundamentals and geostrategic importance of energy transit will be discussed. Later, historical efforts to achieve an international energy transit regime under the Energy Charter Treaty, which was established in 1994, will be examined. This will be followed by a discussion on current infrastructural developments and analysis of new geopolitical realities as well as market-related developments in the Eurasian energy landscape. The last part of the paper will strive to question the possibility of a regional, but not international, energy transit community under the new International Energy Charter declaration.

11.2 Importance of Energy Transit

Before proceeding into a detailed discussion, it is required that a brief introduction to the concept of energy transit security and an explanation of its importance of the increasingly interdependent energy order. The concept of energy security has been more and more integrated into the general framework of international economic and political security in an economically interdependent and even globalized world order. In its most fundamental sense, energy security is an assurance of the ability to access the energy resources and required for the continued development of national power. In more specific terms, it is the provision of affordable, reliable, diverse and ample supplies of oil and gas (and their future equivalents) to the states and adequate infrastructure to deliver these supplies to the market.[1] Since all actors in the energy value chain are interested in a well-functioning and uninterrupted flow of transportation system for energy commodities, transit security is now at the center of all energy debates.

The energy transit security has high complexity by definition, since it requires continuous, consistent and dynamic multilateral cooperation between involved actors that focus on their own and most time very specific interests. Therefore, it is reasonable to say that energy transit security is not a strictly defined term yet. However, uninterrupted and predictable flows of energy commodities and materials are common points in definitions of the concept. Investments on new energy transit infrastructure projects are often long term and capital intensive. Therefore, attracting investments into new or upgrading existing, transit infrastructure requires a favorable investment climate. Encouraging conditions include a transparent, stable and predictable framework on access and utilization, transit tariffs and charges, security and safety standards, emergency and undisputable management.

Transit countries enjoy some material, and often geostrategic benefits from the transportation of energy through their territories as search for reliable transit of energy goes parallel with the multi-dimensional, evolving, and highly politicized nature of energy security. As Xuetang (2006) argues, the main drive for this is the understanding that control over oil and gas pipelines is more important than possession of oil and gas resources, because whoever controls the lifeline of transportation in fact controls the energy resources.[2] As a result, controlling the flow of energy transit gives a strong leverage to countries in their international relations with both energy exporting and importing countries. Thanks to the importance of energy transit those countries have a say international energy arena, otherwise this is not the case. Position of Ukraine as a transit state for Russian energy supplies to Europe gave the country important bargaining power in persuasion of its energy interests in Russia-Ukraine gas crises. In order to deprive Ukraine of this transit power Russia has started to develop new and costly pipeline projects such as Nord Stream, South Stream, Turk Stream, all of the possible projects aim to by-pass Ukraine . The complicated and highly political nature of the energy transit makes it difficult to achieve an international agreement that regulates energy transit between various stakeholders, even though some endeavors are observed on the subject. Although an international binding regime for energy transit has not been established yet, the main

[1]Jan H. Kalicki and David L.Goldwyn, (2005) The Need to Integrate Energy and Foreign Policy, in Jan H. Kalicki and David L.Goldwyn (Ed.), "*Energy and Security: Toward a New Foreign Policy Strategy*", (p. 9) Washington, D.C.: Woodrow Wilson Center Press.

[2]Guo Xuetang, (2006) The Energy Security in Central Eurasia: the Geopolitical Implications to China's Energy Strategy, *The China and Eurasia Forum Quarterly*, vol. 4, no. 4, November 2006, p. 126.

points for a regulation could be shown to refer to access to infrastructure, arrangement of reasonable tariffs and treatment of non-discrimination.[3]

11.3 Energy Transit Regime and the Energy Charter Treaty

After a brief introduction to the concept of energy transit security and its geostrategic importance, it is indispensable to discuss the historical background of the search for a binding international regime that regulates the international energy transit issues, as well as the main reasons for the failure of such efforts. Regulating transit or cross-border energy transport is a complex task that requires a mix of national, regional and international norms and principles. In search for a binding agreement on energy transit it is fair to observe that in being the only multilateral framework that provides relevant provisions, the Energy Charter Treaty (ECT) is well positioned to become the basis for common transit principles. It is designed to stimulate energy security through the operation of more transparent and competitive energy markets, while respecting the principles of sustainable development and national sovereignty over energy resources.[4] The ECT provisions also address the security of energy transit flows, including non-interruption or reduction of existing transit flows in case of dispute, unless allowed by a contract, agreement, and etc. The prerequisite is that the transit infrastructure already exists. The aim is to provide a balance between the sovereign interests of states and the need for stability of energy flows.

In fact, transit provisions of the ECT are built upon the non-discrimination principle embodied in Article 5 of the World Trade Organization (WTO) but go beyond it, as they contain explicit obligations relative to the energy transit. Accordingly the transit countries must not interrupt or reduce existing energy flows, even if they have dispute with any other country concerning the transit.[5] In fact, the WTO and the ECT are highly similar as far as the above-mentioned provisions are concerned. Moreover, it is impartial to note that overlapping provisions of the ECT and the WTO on energy transit make the issue complicated. Which of them could provide a diplomatic instrument to handle the energy transit related issues is still an open debate. For instance, Pogoretsky argues that specifically natural gas can be accepted to interpret the meaning of goods under the WTO and subject to international trade law in which the WTO Article 5 applies to the transit of natural

[3] Han Wang (2016) Towards a Cooperative Framework For a China-Central Asşa Transit Community. Energy Charter Occasional Paper Series . http://www.energycharter.org/fileadmin/DocumentsMedia/Occasional/China-Central_Asia_Energy_Transit_Community.pdf. Accessed 31 Mart 2017.

[4] See the consolidated version of the ECT with positive Annex W, available at: http://www.energycharter.org/fileadmin/DocumentsMedia/Legal/ECT-Positive_Annex_W.pdf/

[5] Tamar Tsurtsumia (2014) Gas Transit Through Georgia in the light of Energy Charter and Energy Community Provisions. Energy Charter Occasional Paper Series. http://www.energycharter.org/fileadmin/DocumentsMedia/Other_Publications/20151218-Gas_Transit_through_Georgia-Energy_Charter___Energy_Community_Provisions.pdf Accessed 16 April 2017.

gas via pipelines, as a 'good' in transit.[6] For others, the transit provisions of the ECT should only influence the interpretation of, as well as efforts to revise, Article 5 of the WTO to overcome implementation problems.[7] However, there are still some remarkable differences on energy transit between these two treaties: Article 7 of the ECT goes beyond the WTO Article 5, since it introduces a weak type of national treatment obligation, namely that a transit country may not treat energy materials and products in transit in a less favorable manner than such materials and products originating in or destined for its own area. Furthermore, the ECT addresses investments into new infrastructure, e.g. in Article 7(4) that prohibits Contracting Parties from placing obstacles in the way of new capacity being established if transit cannot be achieved on commercial terms by means of existing infrastructure, or in Article 10(2) and (3), obliging the Parties to endeavor to accord national treatment to investors in view of the making of investments in its area.[8] Article 5 of the WTO provides the definition of traffic in transit, namely "*when the passage [of goods] across [the territory of a member] ... is only a portion of a complete journey beginning and terminating beyond the frontiers of the [member] across whose territory the traffic passes*". Transit is understood as through-transit, meaning the carriage of energy materials and products across the Area (territory) of a Contracting Party.[9] This normally involves three countries—the country of origin, the transit country and the country of destination. On the other hand, for the ECT, it is sufficient that the transit country and at least the country of origin or the country of destination is a Contracting Party. In the article 7 (10) of the ECT, transit is defined the following way[10]:

> (a) "Transit" means
>
> (i) the carriage through the Area of a Contracting Party, or to or from port facilities in its Area for loading or unloading, of Energy Materials and Products originating in the Area of another state and destined for the Area of a third state, so long as either the other state or the third state is a Contracting Party; or
>
> (ii) the carriage through the Area of a Contracting Party of Energy Materials and Products originating in the Area of another Contracting Party and destined for the Area of that other Contracting Party, unless the two Contracting Parties concerned decide otherwise and record their decision by a joint entry in Annex N. The two Contracting Parties may delete their listing in Annex N by delivering a joint written notification of their intentions to the Secretariat, which shall transmit that notification to all other Contracting Parties. The deletion shall take effect four weeks after such former notification.

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[6]Vitaly Pogoretsky (2017) Freedom of Transit and Access to Gas Pipeline Networks under WTO Law, Cambridge University Press.

[7]Danea Azaria (2009) Energy Transit under the Energy Charter Treaty and the General Agreement on Tariffs and Trade *Journal of Energy and Natural Resources Law* (4) pp. 559–596.

[8]Ibid. Tsurtsumia. . .

[9]Text of Article V and Interpretative Note Ad Article V of the WTO. https://www.wto.org/english/res_e/booksp_e/gatt_ai_e/art5_e.pdf Accessed 26 February 2017.

[10]See the consolidated version of the ECT with positive Annex W, available at: http://www.energycharter.org/fileadmin/DocumentsMedia/Legal/ECT-Positive_Annex_W.pdf/ Accessed 28 February 2017.

The definition of transit also includes the case where energy materials and products are destined for the country of origin, when this carriage involves transit through another country. In this case transit involves only two countries. It is again worthy to note that the ECT reaffirms national sovereignty over energy resources and does not impose any kind of market structure, including mandatory third party access, unbundling or a detailed regulatory framework for the operation of energy transport infrastructure. The interruption or reduction of existing transit flows in view of a dispute over transit is prohibited, unless allowed by a contract, agreement or a Conciliator's decision. A dispute resolution mechanism involving a Conciliator is also available under Article 7(7). In case of an interruption, the Contracting Parties shall encourage relevant entities to cooperate in mitigating the effects of such interruption.

Nevertheless, the terms in Article 7 of the ECT are general and not enough to regulate the energy transit issues. Due to this reason, the ECT constituency felt that general principles of free movement of transit needed further elaboration. Therefore, the idea of a specific protocol to develop Article 7 appeared shortly after the negotiations of the ECT. Accordingly, the parties to the Treaty started negotiations to draft a more detailed transit protocol in 1998. There was a shared view that common rules on energy transit need to respect a balance of interest between energy producers, consumers and transit countries. The result was the Draft Transit Protocol which was introduced in 2003.[11]

The main purpose of the protocol was to delineate rules regarding the implementation of the Treaty's principles and relative provisions on the transit. The binding nature of the obligations resulting from transit agreements, the effectiveness of national legislation in ensuring non-discrimination, and the prohibition of unauthorized taking, interruption, reduction or stoppage of established flows of energy materials and products were among the key principles agreed upon during the negotiations. Technical definitions such as available capacity and capacity utilization methods were effectively elaborated, and a consensus was reached on the underlying principles of transit tariffs.[12] However, in 2003 negotiations were suspended due to a lack of common understanding between negotiating parties on some critical matters. Three main issues were the subject of consultations between the EU and the Russian Federation and, later on, among all the ECT Contracting Parties during that time. The issues under consultation included:

– The long-term capacity booking and creation of new transit infrastructure;
– The cost reflectiveness of tariffs arising from auctions;

[11]Final Act of the Energy Charter Conference with Respect to the Energy Charter Protocol on Transit, 31 October 2003.

[12]Ernesto Bonafe and Gokce Mete (2016) Escalated Interaction between EU Energy Law and the Energy Charter Treaty. *Journal of World Energy Law and Business (9)* pp. 174–188.

– The clause introduced by the EU having the effect that the Protocol would not apply to energy flows within the EU ("REIO clause").[13] (make this one continuing sentence)

After some setbacks in the process, the issue had been revitalized and again long discussions took place among the constituency. The signatories also decided that provisions on third-party access to available network capacity should be based on negotiations. Nevertheless, Russia insisted that the existing network user, whose contract has expired, to be given the first opportunity to accept the conditions offered (by the network operator) for any such new request for that available capacity (so-called right of first refusal).[14] This proposal was contested by the EU as it carried the risk to create market barriers detrimental to competition. Later the discussions continued, but the parties did not manage to agree on the final version of the transit protocol. After withdrawal of Russian Federation from the ECT in 2009 and unwillingness from the EU, the negotiations on the Transit Protocol were again suspended in 2011, mostly because the draft text was no more accepted as a basis by a large group of states and there was lack of political will by the parties to the ECT. Consequently, long endeavors to create an internationally binding agreement on energy transit were halted without any concrete results. Nevertheless, search for a multilateral transit protocol has not totally ended. In November 2011, in view of the possibility to reset negotiations on a new Transit Protocol and develop multilateral rules to facilitate cross-border energy transport and transit, the Energy Charter received a mandate from its member states to launch consultations among members, observers and other relevant stakeholders from government and industry. The result of these consultations was discussed at the Conference meeting in Warsaw and concluded that transit negotiations might be reset based on a new document reflecting the common views of the constituency if an important number of stakeholders/constituency expressed a sincere interest in such negotiations and commitments. An energy transit mechanism has been also witnessed in UN Resolution 67/263 (2013) entitled: "Reliable and stable transit of energy and its role in ensuring sustainable development and international cooperation" that was promoted by Turkmenistan and supported by 72 states, of which most are ECT members.[15] Close cooperation between Turkmenistan and the Energy Charter Secretariat on the implementation of the Resolution then resulted in a series of meetings of international experts on energy transit. Jointly organized by the government of Turkmenistan and the Energy Charter Secretariat, the last International Meeting of Experts took place in Ashgabat (May 2017). In line with the conclusions of the 2014

[13]Ibid. Tsurtsumia. . .

[14]Art 8(4) DTP; Andrey Konoplyanik (2004) Transit Provisions of the Energy Charter Treaty and Draft Transit Protocol (Energy Charter Secretariat's conference 'Energy Transit in Eurasia: Challenges and Perspectives', Brussels, Belgium, 19–20).

[15]UN Resolution 67/263, http://www.un.org/en/ga/search/view_doc.asp?symbol=A/67/PV.82 Accessed 1 August 2017.

Review under Article 34(7) and the Astana Declaration of the Energy Charter Process for 2015–2019, a New Multilateral Transit Framework is agreed to be started which addresses various aspects of oil, gas and electricity transit.[16] There is still a desire to form a kind of international energy transit regime but when determining the rules of energy transit one should take into consideration that time-honored developments regarding the energy infrastructure in particular and markets, as well as geopolitical developments in general which are very different from the realities of two decades ago when the first negotiations started on energy transit protocol.

11.4 Ongoing Projects Regarding the Energy Transit in Eurasia

The vast number of large and different forms of infrastructure projects in Eurasia illustrates the need for a common legal and regulatory framework to facilitate cross-border electricity trade and transport. There are numerous international agreements among states, as well as between host countries and companies, concluded to facilitate individual cross-border and transit energy transport projects in the wide region of Eurasia. Their terms and conditions vary greatly. As a rule, each project has its own unique legal regime which is based on certain principles and rules of general international law, applicable regional instruments, and norms of bilateral pipeline agreements and provisions of commercial contracts between various private parties. As a guiding principle, based on Energy Charter model agreements, often an Intergovernmental Agreement (IGA) is signed by the host states of the transport project. The agreement is usually referring to a specific infrastructure, although there are examples of framework agreements of general application (i.e. covering all infrastructure projects between the states concerned). To supplement the IGA, in practice a Host Government Agreement (HGA) between an infrastructure owner (pipeline or grid owner) and the host government is signed. On the other hand, the status of national and cross-border transmission access conditions and tariff methods for countries differs greatly. For instance, the EU countries manage to develop their own principles and regulations on a common market basis. Most non-EU 'transit countries' treat national transmission flows differently from cross-border transmission, applying different tariff models, access and market rules including negotiated tariffs for transit.

Diverse intergovernmental agreements also form the basis for transit, swap and cross-border energy trade. In general, at least three actors are involved in most energy transit operations. However, in some cases, energy commodities are traded just between two neighboring countries in the form of cross-border energy transport. In other cases, there is just swap of oil, gas or electricity between the countries. Increasing electricity trade among the South Caucasus states is a clear example of

[16]Energy Charter Conference: Turkmenistan's Chairmanship Ashgabat 2017 http://www.energyashgabat2017.gov.tm/en/news/34 Accessed 5 August 2017.

different kinds of international energy trade. The countries around the Caspian basin compose an important part of the ECT constituency, having experience on energy transit regulations through different kinds of international legal mechanisms for years. The significance of the Energy Charter Treaty (ECT) in the development of rules and principles for oil, gas and electricity transit especially in the South Caucasus has been publically recognized by decision makers in the region. ECT rules, as guiding principles on transit have been observed by the governmental actors operating energy systems along the transit corridors; Armenia, Azerbaijan and Georgia (as well as other Caspian and Black Sea states) have all signed and ratified the ECT and actively participate in the Energy Charter Process. As an example, cross-border electricity transportation at a bilateral level includes Georgia-Turkey, Azerbaijan-Georgia and Georgia-Armenia. In addition to this, since February 2016, an electricity swap has started between Azerbaijan and Turkey to feed the Nakhchivan exclave of Azerbaijan. What makes the issue more complicated is the fact that Azerbaijan also uses the Georgian grid as a transit for its swap operations with Turkey. Another example of this complex transit/transport projects in Eurasia is the Trans-Anatolian gas pipeline (TANAP) which is the newest pipeline in Eurasia and it is unique in terms of its specific status. Although it is designed to serve for cross-border energy transport, it differs from other oil and gas projects in that it is not a cross-border pipeline. In fact, it is a national transmission line, starting at the Turkish-Georgian boundary and terminating at the EU-Turkey border, but it is regulated by an Intergovernmental Agreement. The TANAP also exposes the economic (competition and regulatory policies) and political deficiencies of the existing Eurasian pipelines whose international and cross-border character has prevented the involved countries' interest-maximization.[17] With its distinct character, TANAP contributes to an already complicated system of international transit projects in Eurasia. Furthermore, the interconnection of TANAP into a cross border project, the Trans-Adriatic Pipeline (TAP), under the concept of the "Southern Gas Corridor", complicates the issue. TAP will end in Italy after passing through Albania and is partly exempted from the EU legislation (Third Energy Package). A possible interconnection of TAP to another project, which is called Ionia Adriatic Pipeline (IAP), is also possible. The IAP is projected to cross the territories of Albania, Montenegro and Bosnia Herzegovina, which are all members of both the Energy Community and the ECT, before reaching the Croatian border.

Among the different international energy transport projects in Eurasia, east of the Caspian Basin, has special peculiarities. It is important to underline the fact that, in the context of the Caspian resources, the export route in the gas sector was focused on the East–West transport corridor in the 1990s. Nowadays, the focus has shifted to the East–East corridor with also export potential to Asia. Turkmenistan is now China's biggest gas supplier and the planned pipeline from Turkmenistan to Afghanistan, Pakistan and India (TAPI), if constructed, could further reinforce the

[17]Volkan Özdemir, et al. (2015) The Trans-Anatolian Pipeline (TANAP) as a unique project in the Eurasian gas network: A comparative analysis. Utilities Policy. vol. 37, issue C, pp. 97–103.

dynamics in Asia towards South and East Asia. The Central Asia–China gas pipeline which runs alongside several transit states (Uzbekistan, Kyrgyzstan, Tajikistan and Kazakhstan) is different from the other projects as the transit risk is attached to the buyer, but not to the vendor, in this case. Furthermore, it is important to note that the eastward shift in energy transport routes does not only cover the natural gas sector, but also to oil and electricity sectors. As for oil, in addition to the already constructed the Caspian Pipeline, and the Baku-Tbilisi-Ceyhan crude oil pipeline, also the Kazakhstan-China pipeline and ESPO pipelines bring increasing amounts of crude oil to the Chinese market. In addition, maritime oil transport between Kazakhstan and Azerbaijan through the Caspian Sea is also observed. The transportation of Tengiz oil (Kazakhstan) began in 2008 and these volumes have been transported to the Batumi and Kulevi Oil Terminals. With this transportation, Azerbaijan has also become an oil transit country. Oil transit through the Turkish straits is also another important factor that makes the issue more complicated. For electricity, in addition to ongoing cross-border electricity trade among Central Asian countries, the CASA-1000 project developed by the World Bank allows for exports of hydropower surpluses from Central Asia to energy deficient countries of South Asia—Afghanistan and Pakistan. The initial concept of Gobitec and Asian Super grid projects is being developed by the Asian Development Bank with the involvement of countries of Northeast Asia.[18] Here it is important to remark that unlike oil and gas, electricity is mainly traded regionally in the form of cross-border transport.

11.5 New Eurasian Geopolitical Realities and Energy Market Developments

In addition to ongoing energy transit and transport projects in the wide region, it is also important to analyze new geopolitical developments and market related changes in Eurasia. In terms of geopolitical changes that could have effect on international balance of power, three main factors have emerged in recent years. Those are: (a) increasing China's involvement in energy routes and the Energy Charter process due to the investments on transit from Central Asia, (b) lifting of sanctions against Iran and (c) Turkey's increasing role in various energy transit projects.

(a) China's economic development and increasing international presence are important factors that could have political ramifications in Eurasian energy transit projects. With the start of the Asian Investment and Infrastructure Bank and the emergence of a grand infrastructure project: 'One Belt One Road' (OBOR), China is striving to create a new Silk Road in which energy is the main element. From China to Europe, a new transit area for energy sources is

[18]Shuta Mano, et al. (2014) Gobitec and Asian Super Grid for Renewable Energies in North East Asia. Energy Charter Publications. http://www.energycharter.org/fileadmin/DocumentsMedia/Thematic/Gobitec_and_the_Asian_Supergrid_2014_en.pdf Accessed 25 March 2017.

emerging from various kinds of projects. This could be a big catalyzer for an energy transit agreement under a future Energy Charter Process with further involvement of China. A main part of OBOR is the Silk Road Economic Belt from western China, crossing Central Asia on its way towards Europe through Iran and Turkey.[19] While pipelines and accompanying projects have increased in recent years, the allocation of new transit capacity from different counterparts along pipeline routes has become a main issue that China needs to tackle to secure its national energy supply. Huge Chinese investments on the energy infrastructure in Central Asia are not legally secure and the region is still exposed to unpredictable internal and external political tensions. The last tension has becoming especially true for Kazakhstan, a country that has a significant ethnic Russian population, after the annexation of Crimea by Russia and the turmoil in Russian-dominated areas of Eastern Ukraine. It is fair to observe that, different from the situation in the 1990s, Turkmenistan is now China's biggest gas supplier and ongoing projects could further reinforce dynamics in Asia towards South and East Asia. The eastward shift in energy transport routes does not only cover the natural gas sector but expands to oil and electricity, in line with China's One Belt One Road initiative. Therefore, a more efficient and comprehensive international legal framework would facilitate the security of energy flows to China. It is important to underline the fact that China is not a party to the ECT but it has already shown interest to the Energy Charter process by signing International Energy Charter (IEC) in May 2015. China's active participation to the Energy Charter process and its commitment to the IEC could have potential to reassess the energy transit issues in Eurasia from a new perspective.

(b) Lifting sanctions against Iran, and more energy export from that country should also be taken into consideration while discussing a new international energy transit agreement as nuclear negotiations between Iran and P5 + 1 countries (UN Security Council permanent members and Germany) result in positive outcomes. This situation further creates potential to integrate Iran into the global energy markets via new infrastructure projects. Iran could export more energy to Europe through Turkey, to Asia (Pakistan, India and China) and through new LNG facilities to international markets. The lifting of sanctions against Iran could result in participation of Iran in the Southern Gas Corridor and could also pave the way for energy exports from Turkmenistan to Turkey. Under this option, Iran will be able to export its gas to Europe via Turkey, Turkmenistan may also bring its gas to Turkey and Europe via Iran under a swap deal. Iran, like China, is not a party to the ECT, but it has adopted the International Energy Charter in May 2015, and this could produce same potential to reassess the energy transit issues in Eurasia from a new perspective.

[19]Criselda Diala-Mc Bride (2016) OBOR and the Future of Energy Trade. https://www.eniday.com/en/sparks_en/obor-china-global-energy-map/. Accessed 1 April 2017.

(c) Turkey is a key factor in the fulfillment of the development and expansion of the Eurasian energy projects. This is in keeping with Turkey's aspirations to become an important energy transit country with its geographical location between Eastern producers and the Western consumers and the fourth largest gas artery in Europe after Russia, Algeria and Norway with the realization of the ambitious TANAP project. Therefore, Turkey's energy strategy seems to comply with the European concept of a Southern Gas Corridor. With the Baku-Tbilisi-Ceyhan oil pipeline (BTC), the South Caucasus gas pipeline and the Turkey-Greece pipeline now being operational, Turkey can claim to have taken an important step towards achieving this policy. With the newest geopolitical developments regarding Turkey, stemming mainly from the Middle East, Turkey could now become more eager to realize new energy infrastructure projects designed to bring more energy resources to the international markets. On the other hand, the Caspian and Central Asian countries have also been seeking market access to Asia and Europe for their reserves through participating in various pipeline projects and they need a well-defined energy transit regime, linking Caspian oil and gas to consumers eastbound to China and westbound to Europe, as well as north-south energy transmission linking South Caucasus with Iran. It is advantageous that Turkey, the Caspian and Central Asian countries being active members of the Energy Charter process from the beginning, are also parties to the IEC declaration.

These three main and relatively new geopolitical developments converge with each other in the Eurasian energy landscape. By noticing that Russia is no more a part of ECT therefore the EU is focusing on its own energy legislation and its externalization through Energy Community. The influential power of China and Iran on further involvement on the Energy Charter process could revitalize the importance of energy transit in Eurasia.

In addition to those three main geopolitical developments regarding China, Iran and Turkey, there are also new developments related with the transformation in specific energy market structures and related regulations. Regarding the natural gas market, in recent years, there has been a tendency for the proliferation of LNG projects worldwide, whether liquefaction or regasification terminals, or floating terminals. This not only contributes to the energy supply but also transforms the international gas market into a more flexible and united one with increasing unconventional oil and gas production capacities. The isolated regional gas markets are now in transition to an integrated one, in which the pattern of trade has been changing, i.e. gas to gas competition is replacing the traditional oil indexation in terms of pricing. Due to these developments, the natural gas industry is no longer characterized by only high pressure transmission lines. Any regulation on transit should also take LNG trade into consideration since the trade has gained importance and in some cases LNG volumes are being re-exported to third countries after entering the territory of one state. Another transformation has been observed in energy regulations different form the 1990s. A regulated third party access (TPA) regime that takes into consideration the specific characteristics of each of the commodities is crucial. Interdependence of the network and the commercial elements of the energy industry require fair and transparent regulation for the new entrants to transport infrastructure. The energy governance of the European Union (EU) has a sophisticated legislative and decision making history on the tradeoff between investment and liquidity. The EU experience indicates that exemption from third party access, unbundling and regulated access tariffs all operate through the guiding principle of competition where neither investment incentives nor wholesale market liquidity are compromised at the expense of the other. The main institutional task for future transit instrument is establishing and implementing the *access-exemption balance*. Search for a new international energy transit regime should take developments in the EU regulations as an advanced form of legislation into consideration. Here the concept of *dynamic competition* might be adopted to find a balance between facilitating access to transport infrastructure and promoting new investments. Underlying the viability of a balanced access-exemption regime, for instance, both the Second and Third Gas Directives of EU contain articles on exemption.[20] These exempt the relevant parties ex ante from ex post regulations.

11.6 A New Transit Regime Under the International Energy Charter?

All those new developments, mentioned above, on both geopolitical and market aspects lead to a whole new understanding of energy transit issues in Eurasia. Therefore, a new energy transit regime should be discussed with a reference to the realities of today's world which is different from the earlier decades. On the one hand, the search for an international energy transit agreement/protocol under the ECT has not yielded the desired results yet. On the other hand, there is still search for such kind of an agreement especially among some participants of the Energy Charter process. It is indispensable to keep in mind that once influential and eager members of the ECT, namely the EU and Russia, are either not interested or out of process to form an energy transit agreement. Nevertheless, the need for a binding energy transit regulation especially in a wider region, from China to Europe, in which there is lack of an international and multilateral energy transit regulation, is actual. If the exit of Russia from the ECT and decreasing interest of the EU to the energy transit under the ECT could be seen as negative signs for the transit protocol, there are also positive developments that could pave way for a formation of a regional energy transit regime with a special reference to the IEC this time. The ECT with its current membership structure is old and not sufficient to provide an attractive basis of increasingly important energy actors that are not party to the ECT, like China and Iran. Therefore, taking the withdrawal of Russia from the ECT and the EU's focusing on its own energy legislation into account, a new initiative for establishing an energy transit regime for the countries from China to Europe should firstly be based on the interests

[20](2003/55/EC and 2009/73/EC).

and requirements of other leading actors with a whole new approach in a specific region. Otherwise, the current parties to the ECT could potentially block a proposed energy transit agreement. Therefore, rather than an international one, a new multilateral approach on energy transit should target a regional energy transit regime, which covers energy transit issues related with China, Iran, Turkey and Central Asian and Caspian countries' problems at first.

A new approach for a multilateral framework on energy transit, by taking into consideration of the peculiarities of ongoing projects from China to Europe, should focus on creating a regional transit community which covers not only energy transit issues but also energy transport and swap operations as well. The new regional transit community under the IEC should address the creation of new transit infrastructure, as new projects are elaborated in this part of the world. New infrastructure is rarely planned as transit infrastructure from the beginning.[21] In terms of customs regulation, energy transit, energy swap and cross-border transport are each subject to different trade regulations. The transit is by definition customs free. Only a few basic regulations of the transit country, essentially related to security issues, have to be observed usually. Transit swap operations are considered as virtual transit if they combine a contract at the entry point of one country with a contract at the exit point of that county. If both, entry and exit points lie outside the transit country, the transit swap contracts give rise to a genuine virtual transit. If one of the points lies within the transit country, that country becomes either an importer or an exporter. Most often transit infrastructure projects are initially realized as cross-border infrastructure, then they become transit infrastructure after third countries have been physically connected them. That is why the new approach should not be limited only to the transit issues. Rather cross-border transport of energy as well as swap agreements for energy commodities have become extremely important and only a regional transit community could cover all of those. A multilateral framework for energy transit community as well as risk management mechanisms would provide transparent rules that will facilitate investment decisions for the expansion of energy transport facilities. Therefore, based on a broader definition of energy transit that encompasses cross-border energy transport and transit swap operations in addition to transit under the IEC seems to be the only viable option. Otherwise, past negative experiences on establishing a binding transit agreement could fail to take into consideration the nature of ongoing infrastructure developments in the region.

In line with the changes underway in the Eurasian energy arena in terms of economic, political and legal developments, emergence of the International Energy Charter was a necessity of geographical expansion of the Energy Charter process. As a political declaration, the IEC was adopted on 21 May 2015 with a broader participation than the ECT; more than 65 countries and organizations signed the declaration.[22] The International Energy Charter could be used as a guiding instrument to achieve a multilateral understanding on energy transit issues as the recent

[21] A swap operation is a combination of two contracts concerning the same product.

[22] https://ec.europa.eu/energy/en/news/new-international-energy-charter-adopted

and most modern document of the Energy Charter process. The IEC provides a platform to facilitate regional cooperation, enhance confidence in investors and encourage energy interconnection projects with a wider geographic scope. It is remarkable to note that the IEC, as the latest stage of modernization of the Energy Charter process, reiterates the principles of non-discrimination and market-oriented price formation that are key for a new transit instrument. The IEC remains instrumental to protect the market interests of large energy consumers and represents at best incremental progress vis-à-vis linking the interests of producers, transit states and consumer states.[23] The multilateral character of energy transit cooperation and access to energy is addressed in the IEC, which was adopted and signed by over 70 parties in May 2015. The declaration states that "*Recognizing the importance of energy security of energy producing, transit and consuming countries, regardless of their state of economic development, as well as access to modern energy services, which needs to be based on environmentally sound, socially acceptable and economically viable policies, with emphasis on mutual responsibilities and benefits*".[24] The IEC promotes the development and interconnection of energy transport infrastructure, the regional integration of energy markets, and supports cooperation among states regarding the transport infrastructure. The ECT is a binding agreement by nature whereas the IEC is a political declaration. Still there is no legal obstacle for a new regional energy transit community from China to Europe including Central Asian and South Caucasus states, to be formed under the IEC. The IEC seems to be the only guiding instrument for a regional transit community to be formed in Eurasia by its modern vision of international energy developments. If achieved, the new regional transit community under the IEC declaration would fill the legal and political vacuum on energy transit issues in Eurasia.

11.7 Conclusion

To sum up, rather than search for a whole international energy transit framework under the ECT, a new and specifically a regional energy transit community that regulates energy flow from China to Europe, under the International Energy Charter, could be established in Eurasia. Taking the withdrawal of Russia from the Energy Charter Process and the EU's focusing on its own energy legislation into account, an initiative for establishing such kind of a new regional energy transit community should at first address the interests and needs of increasingly influential energy actors in Eurasia namely China, Iran and Turkey. According to this new approach, the regional transit community will extend along from China to the East and from Turkey to the West, including all countries in-between and without involvement

[23]Pami Aalto (2016) The new International Energy Charter: Instrumental or incremental progress in governance? *Energy Research and Social Science vol.11* pp. 92–96.

[24]International Energy Charter, See full version, available at http://www.energycharter.org/fileadmin/DocumentsMedia/Legal/IEC_EN.pdf. Accessed 3 August 2017.

from Russia or the EU which has focused on its own energy policies and regulatory frameworks. The new Silk Road program of China, the lifting of sanctions against Iran and Turkey's growing presence in Eurasian energy landscape support such kind of a geostrategic vision. This initiative can also revitalize the Energy Charter process which has long been ignored. In fact, the ECT has played a role in international energy arena for two decades since its first appearance in mid-1990s. Now it is time for the IEC to repeat the same role as new emerging legal instrument for a new international energy structuring. In this sense, the regional energy transit community under the IEC is an important opportunity for Energy Charter process. Last but not the least, if institutional capacity could be enhanced under the IEC, the new regional energy transit community will not only regulate the energy trade and transit among the parties to the declaration, but also potentially contribute to the political stability in Eurasia as a multilateral binding legal regime that is the basis of any geostrategic calculations.

12

Geostrategic Importance of East Mediterranean Gas Resources

Sohbet Karbuz

Abstract

A series of major natural gas discoveries and the prospect of substantial hydrocarbon resources waiting to be tapped beneath the Eastern Mediterranean waters have sparked major international interest. If developed in a timely and successful way, current and future discoveries may significantly change the energy picture of the region. Exploitation and export of these resources will require overcoming numerous challenges with geopolitical implications. As a matter of fact, being perhaps the only common denominator, energy will increasingly become a main component of the geostrategic struggle in the East Mediterranean and its surroundings.

The article discusses the exploration, ongoing and planned field development and production activities, the possibilities of gas exports and trade destinations, the options for export infrastructures, and the effect of recent discoveries in Egypt in the Levant region. It will also give an overview of the potential impact of all these issues on the conflict-laden geopolitical landscape of the region in terms of adding a new dimension to establish the power balance. Whether hydrocarbon resources will be a force that unites or one that fuels conflict is hard to anticipate. The article will argue that if not managed carefully, and unless developed for the benefit of all, those resources may fuel confrontations, add frictions and anxieties to an already volatile region, and will shrink the room of optimism for finding a common ground.

Keywords

Natural gas · Hydrocarbon resources · East Mediterranean · Geopolitics

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12.1 Introduction

East Mediterranean[1] holds large hydrocarbon resources even though the countries in the region, excluding Egypt which has an old history of oil and gas production, have been quite slow in finding them. Four large or world scale gas discoveries in less than a decade in the region have opened up a new deepwater province gas bonanza.

At present, total discovered natural gas resources in the East Mediterranean amount to over 3000 billion cubic meters (bcm), around one-third of which occurred in the Levant Basin and the rest in Egypt (OME 2015). And yet, the region remains one of the world's most under-explored or unexplored areas and has good prospects for additional gas, and perhaps oil reserves.

Two assessments by the United States Geological Survey in 2010 (USGS 2010a, b)—one on the Nile Delta and Mediterranean Sea sectors of Egypt, the other on the Levant Basin Province—confirm this. They indicate nearly 9800 bcm of undiscovered technically recoverable gas resources in the region.

The above mentioned discoveries, the USGS assessments as well as the eye-opening resource potential is estimated by the officials in individual countries have not only significantly augmented hopes for large hydrocarbon potential in the East Mediterranean but also made it a fast rising favorite for international oil and gas companies. The following section will provide an overview of upstream activities by countries in the East Mediterranean region. However, this is one side of the coin.

The other side of the coin is that discoveries make sense if reserves in discovered fields are converted into production capacity. The question whether these reserves find their way to the domestic and/or international markets in a timely manner necessitates the development of discovered fields. Companies will carry on costly exploration and field development endeavors if they predict the ability to commercialize their discoveries with a favorable rate of return.

Exploitation and export of hydrocarbon resources present enormous technical, commercial, administrative, security, legal and political challenges with geo-political implications. How to manage and resolve the disputes in the region, particularly those related to the maritime delimitation and the Cyprus problem, remains as another formidable challenge. Section four will discuss all these challenges and will suggest a possible way forward.

As politics shift so does the configuration of the balance of power in line with the changing geostrategic interest of each actor. Substantial gas resources and the opportunities linked to their exploitation and transport have contributed to the shaping a new regional balance of power in East Mediterranean. Section five will investigate the role of natural gas in shifting alignments and geostrategic dynamics. Finally, the last section will offer some concluding remarks.

[1]In this article, East Mediterranean refers to Turkey, Syria, Lebanon, Israel, Palestine, Egypt and Cyprus. Unless stated otherwise, the word "Cyprus" in this article refers to the name of the Island. The Republic of Cyprus (RoC), which is not recognized by Turkey, is usually mentioned by Turkish officials as the Greek-Cypriot Administration. Turkish Republic of Northern Cyprus (TRNC) is only recognized by Turkey.

12.2 An Overview of Upstream Gas Developments in the Region

After the first offshore gas discovery in 1969 in Egyptian waters, exploration activities in the East Mediterranean region has intensified. However, the wells drilled until 1999 in the other parts of the region either encountered hydrocarbon shows but not in commercial quantities or came out dry. A few modest gas discoveries in 1999 and 2000 at shallow depths in Israel and Gaza Strip raised hopes and promoted the acquisition of geophysical data throughout the entire region, particularly in the Levant Basin. After the large scale discoveries in 2009, the region has become a hot spot. More than 1300 bcm of gas were discovered between 1999 and 2017 in the Levant basin (Table 12.1).

Once a gas exporter, Egypt has become a net gas importer since 2015 due to the declining production and booming domestic demand for gas. However, recent discoveries, particularly the Zohr field,[2] has radically changed the picture. Egypt is now expected to become a net gas exporter again in the early 2020s. The discovery of Zohr, which is regarded as a geological game changer, has stimulated new exploration activity in the region.

Israel never lost hope of finding hydrocarbon reserves even after decades of long virtually fruitless exploration efforts. In June 1999, the first natural gas reservoir (the Noa field) was discovered offshore Israel. The first commercial gas field, Mari-B,

Table 12.1 Natural Gas Discoveries in the Levant Basin Province

Fields discovered	Discovery year	Ultimate recoverable reserves (bcm)
Gaza marine	1999	30
Noa	1999	3.5
Mari B	2000	35
Pinnacles	2012	2.9
Tamar	2009	351
Tamar south-west	2013	28.3
Dalit	2009	15.2
Leviathan	2010	621
Tanin	2010	35
Aphrodite	2011	130
Dolphin	2011	2.3
Shimshon	2012	15.6
Karish	2013	50.3

Note: Ultimate recoverable reserves numbers refer to reserves (2P) and resources (Contingent & Prospective) in the best estimate category, and include produced volumes if any. Data are compiled from various sources, including the annual reports of Noble Energy and Delek Drilling, and OME (2015)

[2]With 845 bcm of gas in place, the field is the largest ever gas discovery in the Mediterranean Sea.

followed.[3] Israel's insistence for exploration brought results with the discovery of two large gas fields (Tamar and Leviathan), which were classified as the world's largest deepwater gas discoveries between 2001 and 2010. Further discoveries, albeit small in size, have paved the way for a new era in Israel's hydrocarbons sector.

Gas flow from the Tamar field[4] has started in March 2013. Except for a small quantity of exports to Jordan since January 2017, almost all production from the field has gone to the domestic market. So far 167 bcm of Tamar gas is already contracted to Israeli Electric Corporation and other buyers (Friedman 2017). The Tamar partners are examining the option of expanding the Tamar project to increase the current annual production capacity from 11.5 bcm to over 20 bcm (Delek Group 2017).

Developments of the other fields have been considered necessary for Israeli national security because only one field and one pipeline supply gas to domestic market. However, their development have been jeopardized or unable to proceed as a result of numerous political and regulatory obstacles.[5] Progressively these uncertainties have been lifted. A new gas framework acceptable to companies and Israeli government was finally agreed on 22 May 2016 and the so-called Natural Gas Framework has been established.

In February 2017, the Leviathan partners[6] have taken the final investment decision for the first stage development the Leviathan field. The plan has a proposed budget of $3.75 billion and foresees an annual production capacity of 12 bcm starting by the end of 2019. In the second stage the annual production capacity is planned to be further increased by 9 bcm (Noble Energy 2017; Friedman 2017). A part of the production from the field will have to be used for the Israeli domestic market, as set by the government. To fulfil this obligation the Leviathan partners have signed several preliminary agreements with customers in Israel.[7] However, most of those deals are on "paper only," insufficient to obtain further financing needed for the development of the field. Besides, the Leviathan gas will have to compete with the gas from the Karish and Tanin fields. The situation helps to understand the necessity of binding agreements for amounts of production with potential customers in foreign markets.

[3]Discovered by the US based Noble Energy, gas production at the Mari-B field began in 2004, and at Noa in 2012.

[4]The partners in the Tamar field and the rate of their holdings are: Noble Energy (32.5%), Isramco Negev 2 (28.75%), Avner Oil Exploration (15.625%), Delek Drilling (15.625%), Dor Gas Exploration (4%), Everest Infrastructures Ltd. (3.5%).

[5]Such as the allocation of discovered resources into exports and domestic market, taxation and administrative uncertainties, and an anti-trust ruling stemming from the concerns that Noble Energy and Delek Group constitute monopoly.

[6]The Leviathan consortium is composed of Noble Energy Mediterranean Ltd., operator with a 39.66% interest, Avner Oil Exploration (22.67%), Delek Drilling (22.67%), and Ratio Oil Exploration (15%).

[7]Details on these agreements are provided in Delek Drilling (2017).

Energean Israel, a subsidiary of Greek company Energean Oil & Gas,[8] aims to begin producing gas at the Karish and Tanin by early 2020s. Before making the final investment decision on developing the fields, the company signed with Dalia Power Energies and its sister company Or Power Energies in Israel two agreements to supply 23 bcm gas in total.

The approval of the new Israeli gas sector framework has also paved the way for a resurgence of exploration activity. In 2016 the Ministry of Energy announced to hold successive rounds for new exploration areas in its EEZ (Exclusive Economic Zone). In the first round, 24 blocks that are located in the central part of the offshore area are offered for bidding.[9] However, the ministry has postponed the deadline for submitting proposals twice, probably due to limited interest by foreign companies. The results are expected to be announced in 2018, if everything goes according to plan.

Republic of Cyprus (RoC) held three offshore hydrocarbons exploration licensing rounds. The first round held in 2007 resulted in awarding Block 12, which located on the south eastern side of Cyprus, to Noble Energy in October 2008. In December 2011, Noble Energy discovered the Aphrodite field.[10] However, the field has not yet been developed due mainly to the lack of gas infrastructure and the pending unitization agreement with Israel.[11] In June 2015, the Aphrodite partners[12] submitted an outline development plan for the field, estimated to cost around $4 billion, excluding the building of a pipeline. The Aphrodite partners hope to take the final investment decision in the near future and start production—with an estimated capacity of 8.2 bcm/year—by 2020, if everything goes smoothly. Majority of the production will be exported.

In the second licensing round held in 2012, five blocks were awarded to French, Italian and Korean companies.[13] The well drilled by the Eni-Kogas consortium in block 9 came out dry in December 2014. Afterwards, the consortium drilled another well in the same block but commercially exploitable volumes of hydrocarbons were not encountered. Another bad news came in 2015, when Total gave up its interest in Block 10.

[8]Energean holds a 100% interest in both the Karish and Tanin licenses, acquired from Delek Group in 2016. The estimated cost of developing the field is $1.3–$1.5 billion. For details, see, Energean (2017), Energean Oil and Gas Press Releases dated 20 June 2017 and 30 May 2017, available at the Energean website.

[9]For more details, see a dedicated website by the Ministry of National Infrastructure, Energy and Water Resources at http://www.energy-sea.gov.il/. Accessed 13 May 2017.

[10]When discovered the field was estimated to contain 140 bcm to 200 bcm of gas. In 2014, its estimated resource base was revised downwards to 128 bcm.

[11]Since a small part of the Aphrodite field lies within the area of the Ishai license on the Israeli side, a unitisation agreement is necessary to develop the field. The RoC and Israel have been negotiating a framework agreement since 2014 but no tangible progress has yet been reported.

[12]Noble Energy is operator of Block 12 with a 15% interest, while the Delek Group subsidiaries (Delek Drilling and Avner Oil Exploration) have 15% each, and Shell 35%.

[13]Blocks 2, 3 and 9 were awarded to Eni-Kogas consortium, and Blocks 10 and 11 to Total.

Above-mentioned Zohr discovery in Egypt, just 6 km from Block 11, motivated the RoC to open its third licensing round in 2016. In 2017, three blocks were awarded to winning bidders: Block 6 (Eni/Total), Block 8 (Eni) and Block 10 (ExxonMobil/Qatar Petroleum). In addition, ENI Cyprus Limited has finalized a farm-in agreement with Total to acquire a 50% participating interest in Block 11.

Exploration activities in the Turkish Republic of Northern Cyprus (TRNC) has been rather slow. Turkey signed a continental shelf delimitation agreement with the TRNC on 21 September 2011.[14] A day later the TRNC and Turkey's state-owned Turkish Petroleum Corporation (TPAO) signed a production sharing agreement for one onshore and six offshore blocks around the island of Cyprus (see Fig. 12.1). In 2012, TPAO drilled a well (Turkyurdu-1) onshore, near the town of Iskele, to acquire geological data of the area (TPAO 2013) and TPAO has performed seismic surveys over the offshore blocks.

In Palestine the exploration activities were very limited. Only one small field, the Gaza Marine field, located 36 km offshore Gaza, was discovered by BG (now Shell) in 1999. To date the field could not be developed due to the resistance and blockage of Israel as well as political divisions on the Palestine.

Lebanon and Syria are still considered as frontier exploration areas given that no wells have so far drilled offshore. Lebanon launched its first offshore licensing round in 2012. A total of 46 companies were pre-qualified in 2013 to enter the licensing round. However, the deadline for submitting the bids was postponed five times due to the absence of a well-functioning government, which couldn't approve two constitutional decrees to carry out the licensing round.[15] After their ratification in January 2017, the Lebanese Petroleum Administration (LPA) reopened the licensing round. Five blocks are offered. Meanwhile, in a second pre-qualification round, organized in early 2017, 8 more companies have been designated as prequalified to bid for exploration and production licenses in the licensing round.[16] The winners in the bidding round are expected to be announced in late 2017.

Syria has been keen to attract foreign companies for offshore hydrocarbon exploration activities in order to offset its declining oil output and reduce gas imports. An offshore exploration licensing round for three blocks was announced in 2011 but no bids were submitted due to the crisis in the country. In December 2013, however, the Syrian government signed a 25-year agreement with SoyuzNefteGaz assigning the Russian company an exploration license for Block 2. No progress has been made since then. With the conflicts still raging in the

[14]See, Press Statement No: 216 dated 21 September 2011 (on The Continental Shelf Delimitation Agreement Signed Between Turkey and TRNC), on the website of Turkish Ministry of Foreign Affairs, www.mfa.gov.tr/.

[15]The first one divides the Lebanese Exclusive Economic Zone into ten blocks and sets their coordinates, while the second one adopts the Tender Protocol that defines the conditions for participating in the bid round, the criteria used in the bids evaluation and the model Exploration and Production Agreement.

[16]For more on this, see, http://lpa.gov.lb.

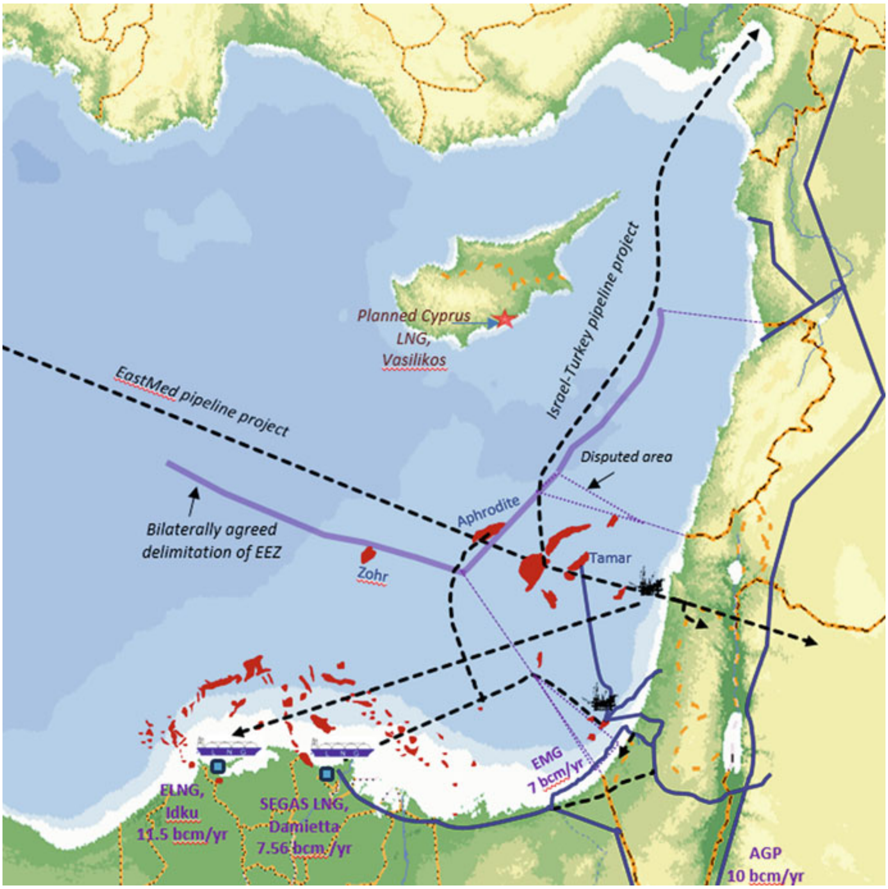

Fig. 12.1 Exploration blocks of Turkey, TRNC and RoC (source: Author's elaboration)

country, any significant development of upstream activities seems unrealistic in the near future.

Turkey has drilled 13 wells in the Mediterranean waters. None of them contained commercial quantity of hydrocarbons. However, Turkey plans to be more active in offshore oil and gas exploration with regular seismic studies and drilling operations in the Black Sea and Mediterranean Sea as outlined in the new "National Energy and Mine Policy," which is presented by Turkish Minister of Energy in April 2017.[17]

[17]See, Turkish Ministry of Energy and Natural Resources (2017).

12.3 Options for Gas Exports and Possible Export Routes

The already discovered gas potential in Israel and Cyprus is more than enough to meet domestic needs for decades. This makes large amounts of gas exports possible. However, the absence of any gas export infrastructure presents a challenge to be overcome.

There are three possibilities to export gas –by pipeline, via LNG (Liquefied Natural Gas), and a combination of both (Fig. 12.2). Exporting gas in the form of compressed natural gas might also be viable in the longer term if it becomes technologically mature and commercially feasible. All these options have been directly linked to the negotiations with potential customers in foreign markets.

12.3.1 Potential Gas Export Routes from Cyprus

Building an LNG plant at Vassilikos on the south coast of Cyprus seemed to be best option to export gas from the RoC to international markets. However, downward revisions of Aphrodite's resource base and disappointing drilling results in other blocks have led to fading away of this option. Bringing the Leviathan gas in Israel would make the LNG project viable but it is not any more discussed. It seems that further gas discoveries offshore Cyprus is the only way to bring the project on the surface again. This is why, the attention has turned to pipelines.

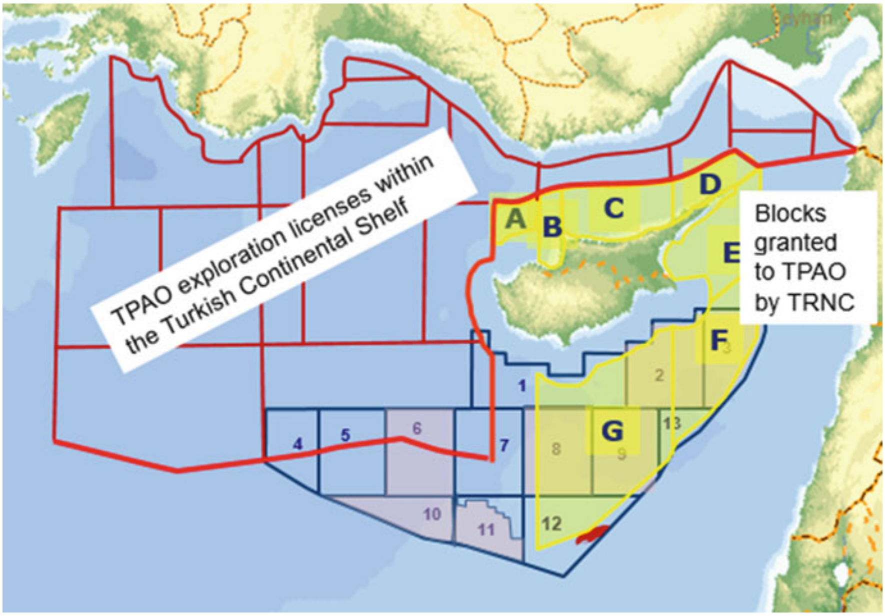

Fig. 12.2 Natural gas export options in East Mediterranean (source: Author's own illustration)

Two pipeline projects are considered—a subsea pipeline linking the Aphrodite field to Europe, and the other to Egypt. East Mediterranean Pipeline (Israel-Cyprus-Greece-Italy), known as EastMed gas pipeline, project with a capacity of 8 bcm/year aims to link Israel and Cyprus to European gas markets. The project has been approved by the EC as a project of common interest, making it eligible for EU funding. The pipeline is estimated to cost over $6 billion.[18] Several high level meetings have taken place to give political support for the project. Lastly, in April 2017, during the Ministerial Summit held in Tel Aviv, in the presence of European Commissioner Miguel Arias Canete, the Ministers for Energy of Italy, Greece, Cyprus and Israel signed a Joint Declaration to reaffirm their support to the swift implementation of the Project. A final investment decision for the project is expected to be taken by 2020.

The other pipeline project aims to bring the gas to Egypt either to be consumed in domestic market or to feed the LNG plants for further exports. In 2014, energy ministers of the RoC and Egypt expressed their readiness to accelerate talks on the potential export of Cypriot gas to Egypt by pipeline, once the resources come on stream. The two countries signed a memorandum of understanding on energy cooperation in February 2015 to explore technical options for the transportation of gas to Egypt. In March 2015, they signed another memorandum of understanding (confirming the previous agreement) that provided for a pipeline feasibility study and for gas exports to Egypt, among other things. Furthermore, in August 2016, RoC's Energy Minister and Egypt's Petroleum Minister signed a deal to build a pipeline to supply gas to Egypt once production starts from the Aphrodite field. Despite the questions about the economic and commercial viability of the project as well as the increasing possibility of Egypt becoming a gas exporter again, negotiations on the issue continue.

12.3.2 Potential Gas Exports Options and Routes from Israel

Several options for export markets and possible export routes have been considered. A Floating LNG facility was a preferred option in the beginning due to its flexibility, but it is not a priority any more due the changing dynamics in global LNG markets.

Building an LNG plant in Israel would be quite a challenge due to security, environmental and suitable space grounds. Alternatively, taking the gas to the Israeli coast and sending it by pipeline to Eilat in Israel and then onward to Jordan's special economic zone at Aqaba (where an LNG facility could be constructed) would be too cumbersome and costly.

Routing the gas from Israel to Egypt and hence the use of Egypt's two idle LNG export terminals could be a cost-effective option but political tensions between Israel

[18] A preliminary engineering study, partly funded by the EU, was undertaken by IGI-Poseidon, a joint venture between Italy's Edison and Greece's Depa. For more on the project, see the website of its promoters - http://www.igi-poseidon.com

and Egypt made access to these plants difficult until the ouster of former Egyptian President Mohammed Morsi in July 2013. Afterwards, the Tamar and Leviathan partners signed several agreements to export gas to Egypt—both for the domestic market and re-export by using the LNG plants located in Idku and Damietta, which have a combined capacity of 19 bcm/year:

- In May 2014, the Tamar Partners signed a non-binding letter of intent with the Spanish company Union Fenosa Gas (UFG) for the provision of 4.5 bcm of gas annually from the Tamar field to UFG's liquefaction plant in Damietta.
- In June 2014, a non-binding letter of intent was signed between the Leviathan partners and BG (now Shell), for the purpose of feeding BG's (now Shell) liquefaction plant in Idku. The estimated scope of the agreement is for the supply of approximately 7 bcm/year.
- In March 2015, Tamar partners concluded a gas sales contract with Egyptian company Dolphinus Holdings Limited to supply a minimum cumulative volume of 5 bcm of gas.[19]

However, currently the prospects of exports to Egypt for domestic market or for re-export activities are weak because of three main reasons:

- First, by the time Leviathan field start producing, Egypt may no longer require gas imports for domestic use. Egypt may start exporting gas again in the early 2020s when production from Zohr and other fields catches up with domestic demand for gas.
- Second, importing gas from Israel would, most likely, be more expensive than importing LNG, if the expected gas glut in LNG markets is taken into account (LNG prices are likely to remain rather stable and low at least over the next 5 years);
- Third, if liquefaction, transport and regasification costs are added, landing price of gas from Idku or Damietta LNG to Europe or Asia would be much higher than importing LNG from any other destination. Moreover, it is highly doubtful that the markets in Europe would be willing to pay a high security premium for diversifying gas supplies.

Those three points also apply to the prospects of exports from the RoC to Egypt, for domestic market or for re-exports.

The Tamar and Leviathan partners have also worked hard to export their gas to other immediate neighbors—Jordan and the Palestine. The following deals have already been signed or are in the making:

[19]This deal faces two major problems: First, it has to be approved by the Egyptian government. Second, the gas should be transported from Ashkelon to Egypt through the existing East Mediterranean Gas pipeline (EMG), one of the provisions of the deal. This, however, has been rejected by EMG's principal shareholders.

- In January 2014, the Leviathan partners and Palestine Power Generation Company (PPGC) signed a deal to sell up to 4.75 bcm of gas, once Leviathan starts production, to feed a 200 MW power plant that PPGC intends to build near Jenin in the northern West Bank.
- In February 2014, a sale and purchase agreement with two companies in Jordan (Arab Potash Company and Jordan Bromine Company) was signed to supply a total of 1.86 bcm gas from the Tamar field. Sales commenced in January 2017.
- In September 2014, Noble Energy Mediterranean Ltd. signed a non-binding Letter of Intent with the National Electric Power Company of Jordan (NEPCO) for the supply of an overall amount of 45 bcm gas from the Leviathan Project to NEPCO.

Gas sales to Palestine and Jordan's NEPCO would surely bring some economic benefits since the use of gas would reduce costs of power generation. Politically, however, gas deals with Israel are not so popular in Jordan and Palestine—they consider these energy deals as a threat to their sovereignty and independence, and a tool to finance Israel's occupation of the Palestinian territories. This is why protests often have taken place against those deals. In March 2015, PPGC cancelled the above mentioned contract due to the delays in development of the Leviathan field, but perhaps politics is weighed more in reality.

Selling gas to distant markets such as Turkey and Europe, has been gaining more importance recently. This is also in line with Israel's multiple gas export strategy. The future of gas demand and hence gas import needs in Turkey is quite bleak. Despite that there has been a considerable commercial interest for buying Israeli gas on the ground because bringing gas from Israel could allow Turkey to further diversify its supply sources and routes, and hence improve its gas supply security. Building a pipeline from the Leviathan field to the southeastern Mediterranean coast of Turkey[20] could allow Israeli gas to target the Turkish market and even access to the European markets, through the Southern Gas Corridor[21] or through the existing infrastructure owned by the Turkish state owned company Botas.

As a matter of fact, in pipeline business politics often comes before economics. Therefore, it was only after the normalization of political ties in June 2016, and particularly during the visit of the Israeli Minister of Energy to Turkey on 13 October 2016 (the first visit of an Israeli minister to Turkey since 2010), Turkey and Israel agreed to enter talks to examine the possibility of such a pipeline project. The negotiations on the pipeline, gas supply terms and other related issues, between

[20]The pipeline, with a capacity of around 8 bcm/yr., is estimated to cost around $2 billion by various sources.

[21]The Southern Gas Corridor is the EU's one of the few non-Russian pipeline gas supply sources and routes. Its current version is composed of the Trans Anatolia Natural Gas Pipeline (TANAP), which will bring gas from Azerbaijan to the Turkey-Greece border, and the Trans Adriatic Pipeline (TAP), which will allow gas to reach the southern coasts of Italy via Greece and Albania. TANAP will have an initial annual capacity of 16 bcm, 6 bcm of which will be supplied to Turkey and 10 bcm will be transported to the European markets -through TAP- from 2019 onwards.

Turkish companies and Leviathan partners on the one hand, and between the Turkish and Israeli governments on the other, continue.

12.4 Challenges with Geopolitical Implications and Possible Way Forward

Exploitation and export of hydrocarbon resources present enormous technical, commercial, administrative, security, legal and political challenges with some geopolitical implications (Karbuz and Baccarini 2017). Technical challenges are centered on infrastructure and financing. For instance, although all the export options mentioned in the previous section are technically feasible, when the costs involved, the complexity of negotiating the necessary deals as well as overcoming political barriers pose serious obstacles to the development of discovered gas resources. Commercial challenges are mainly about the competitiveness of the gas at export destination. Landing price of the East Mediterranean gas at European and Turkey markets are projected to range anywhere from $6 to $8/million Btu (MBtu) which is more expensive than the Russian gas and perhaps LNG. It is doubtful that the importers would accept paying a premium for East Mediterranean gas for the sake of gas supply security.

Administrative challenges include the governments' ability to have the long-term vision for making best use of hydrocarbon resources. Unfortunately, no country in the region has yet developed a comprehensive and successful policy that takes into account of these challenges combined with the region's geopolitical changes.

Security challenges come along with perturbed political relations between the countries in the region. These include the persistent conflicts such as between Israel and its neighbors (the state of war between Lebanon and Israel and decades long conflict between Israel and the Palestinians), the unresolved Cyprus problem, and finally the ongoing unrest in Syria and its impact on Lebanon. As a matter of fact, many of these conflicts are not any more a regional issue, but an international one.

Legal and political challenges are being manifested in the debate and dispute over conflicting claims about the ownership of resources as well as the demarcation of maritime borders. The latter is arguably the most pressing challenge. Disputes can also arise about the delimitation of the geological structures of gas fields in which they are very close to the EEZ borders and possibly overlapping them. The existence of reservoirs overlapping the EEZs could imply a joint exploitation of the field, which would require a unitization agreement between the involved countries.

Maritime borders between Lebanon and Israel have never been agreed upon or delimited officially, so they are an ongoing source of tension. The unresolved demarcation of maritime borders has heightened the diplomatic dispute between Israel and Lebanon since the discovery of the Tamar field in 2009. The disputed area covers 850 km^2. The Lebanese government has offered the area to international companies for oil and gas exploration in its first international bidding round. Later on, in March 2017, Israel made a claim to the UN that the disputed area is "Israeli territory." Today, both Lebanon and Israel argue that they would use force if required to protect their claims. Considering the fact that both countries have never signed a peace treaty makes the situation even more problematic. So far, attempts by the UN and the U.S. to resolve the dispute between the two countries have failed ultimately.

Another complicated case is the one between the RoC, Turkey and the TRNC. Turkey's disagreement concerns the overlapping claims in offshore areas located in the west and south east of the island. Turkey claims that maritime demarcation agreements signed by the RoC with countries of the region are null and void due to several reasons. First, Turkey does not recognize the RoC and hence its proclaimed EEZ. Second, Turkey argues that the Greek Cypriot government does not represent the Turkish Cypriot population. Third, Turkey asserts that unilateral exploration activities are hurting the reunification negotiations. This is why Turkey has been insisting that the RoC halt all exploration activities until a settlement between the two communities in the island is found.

Turkey has no continental shelf claim in the south and east of the island of Cyprus but she has a claim on the west which has been registered before the UN. This is why Turkey opposes to the drilling program in the western part of the island because certain sections of some of RoC blocks (namely, 1, 4, 5, 6, and 7) overlap with Turkey's continental shelf areas in the Eastern Mediterranean. The Turkish Council of Ministers Decrees, dated 30 July 2008, allow the state owned Turkish Petroleum Corporation (TPAO) to conduct geological research and hydrocarbons exploration/exploitation activities in the Eastern Mediterranean. Those areas for which research and exploitation permits were issued entirely fall within the limits of the Turkish continental shelf in the Eastern Mediterranean, according to Turkey.[22] For this reason, Turkey continues to protest the exploration contract for Block 6, awarded in the third licensing round by the RoC, and drilling activities there.

The disagreement on maritime boundaries has immense importance for the Israel-Turkey pipeline project which has to go through the proclaimed EEZ of the RoC (Karbuz 2014). Building such a pipeline would not need a formal permission, but the RoC government must agree on the route of the line, according to the UN Law of the Sea. Moreover, the pipeline project has to fulfil the Submarine Pipelines Regulations of RoC (No.579/2014).[23] The RoC may reject the application or terminate the license for many reasons, including national security and/or public interest. It may also impose terms and conditions into the license. This means that any political friction with Turkey may have impact on the destiny of the pipeline. Seen from this perspective, the EastMed gas pipeline faces a similar problem since it has to cross an area which Turkey regards as a part of its continental shelf.

[22]See, for instance, the Letter dated 12 April 2017 from the Permanent Representative of Turkey to the United Nations addressed to the Secretary-General, available at http://www.un.org/depts/los/LEGISLATIONANDTREATIES. Accessed 11 June 2017.

[23]This requires a license to be granted for laying, construction, operation of the pipeline from the relevant RoC authority; conformity with the Geological Surveys Law of RoC and the Convention for the Protection of the Mediterranean Sea against Pollution and Related Protocols; and an environmental approval.

If the sides continue engaging in unilateral actions, tensions will continue to rise. The RoC is unlikely to give up offshore exploration activities. Turkey and TRNC will keep calling these activities "unilateral and provocative actions,"[24] and the RoC officials will keep calling Turkey's countermeasures as 'provocative' and 'aggressive'.[25] At the same time, Turkish Navy will likely continue "situational awareness" missions in the region.

It appears that unless the Cyprus Problem is resolved, exploitation and transport of natural gas can become a source of serious confrontation and increasingly exacerbate complex geopolitical situation in the region.

Unfortunately, no tangible progress has been recorded after numerous plans for reunification and rounds of UN mediated negotiations. The repeated efforts have been proven fruitless. Although there are great expectances for a settlement in the very near future, potential timing remains unclear. Even if a settlement is achieved, the Cyprus dispute will likely remain an obstacle until Turkey and (unified) Cyprus reach agreement on the EEZ, particularly in offshore areas located to the west and southeast of the island. This, however, also requires resolving the maritime delimitation dispute between Turkey and Greece in the Aegean Sea.

How to manage and resolve the disputes in the region remains a formidable challenge. Nevertheless, the risk of accrued tensions fueled by hydrocarbon resources and transportation infrastructure is very real—it has the potential to fuel new conflicts, exacerbate existing ones and add anxieties to an already volatile region and might even escalate into a full scale confrontation (Leigh and Brandsma 2012).

A zero sum-game logic leads nowhere. A genuine mechanism that would lead to joint exploitation of hydrocarbon resources as well as the development of joint export infrastructure may create interdependencies for paving the way for cooperation in the region (Salem 2012). In case of Cyprus, cooperation on the exploitation of gas resources can help build confidence without prejudicing the eventual outcome of reunification talks (International Crisis Group 2012). In this sense, the best way forward could be through a joint administration and an agreement about sharing of revenue between the two communities in Cyprus.[26]

Bringing all the actors together to effectively collaborate and cooperate could produce synergies and optimization of gas developments. A multilateral forum between all countries in the region, such as the Union for the Mediterranean, could be a potential option but it may not function due to its highly political structure. An informal apolitical setting arranged by bringing together energy companies with industry experts and key institutions and academics could be a better start to advocate energy partnership (Ogutcu and Karbuz 2016). If proven fruitful, it could

[24]See, for instance, Turkish Ministry of Foreign Affairs Press Release No 313, 8 October 2014, No: 74, 25 March 2016, and No: 105, 6 April 2017.

[25]See for instance, Press Release of RoC Ministry of Foreign Affairs on 7 April 2017.

[26]This view is supported by Turkey and Turkish Cypriots. Greek Cypriot politicians, however, are reluctant to support any deal on hydrocarbons with the Turkish Cypriots without a settlement.

later bring governments on board and turn into a new regional institutional setting. This seems to be the best way to establish a balanced but a pragmatic approach and to achieve a solid regional energy cooperation that benefits all parties.

12.5 The Role of Gas in Geostrategic Dynamics

As politics shift so does the configuration of the balance of power, in line with the changing geostrategic interest of each actor. The discovery of substantial gas resources in the Levantine basin and the opportunities linked to their exploitation and transport have contributed to shape a new regional balance of power in the East Mediterranean (Karagiannis 2016).

Deteriorations in political relations between Turkey and Israel since Israel's military campaign "Operation Cast Lead" in the Gaza Strip in 2008 and the Mavi Marmara incident in 2010, as well as between Turkey and Egypt since 2013 have played an important role in shifting the alliances in the region.

In the past few years, two tripartite alignments have emerged. One is between Greece, the RoC and Egypt (since December 2015), and the other is between Greece, the RoC and Israel (since January 2016). High-level political and technical meetings have reinforced tripartite summits bringing top officials from Greece and the RoC together with their Israeli and Egyptian counterparts. At the same time, relations between Egypt and Israel have improved. Another triangle—between Greece, the RoC and Lebanon—is in the making, following the visit of RoC President Anastasiades to Beirut in June 2017.

In addition to cooperation on defense and security related issues, natural gas has constituted one of the principal incentives for building these alignments. Deepening relations among the quartet (involving Greece, the RoC, Israel and Egypt) might lead to a bloc that could jeopardize Turkey's interests in the region and change the regional balance of power at Turkey's expense. Opposite might also happen because the foundations of the alliances which are developed by the RoC and Greece with Egypt and Israel may not be robust enough.

Despite all the rhetoric about being a regional and global leader, Turkey appears to be isolated in the region. It is yet to be seen whether Turkey's warming relations with Israel and Russia will change this picture. Tanchum (2017) argues that, in the future, Turkey and Israel's geopolitical agenda might be shaping the parameters of geopolitics, including energy geopolitics of the East Mediterranean. This argument, however, underestimates the role of external actors in the regional energy dynamics.

The European Union (EU) has interest in the region because it has an energy viewpoint that Eastern Mediterranean gas can strengthen the EU's gas supply security, particularly in Southeast and Central Europe, which are almost exclusively dependent on Russian gas. Following the Russian-Ukrainian gas crisis in 2006, lessening the heavy dependence on Russian gas by means of diversification has become a cornerstone of the EU energy policy. Given the modest quantities that the East Mediterranean and Caspian region can provide to Europe, the introduction of East Mediterranean gas into Europe's gas supply portfolio might not substantially reduce dependence of Russia but at least it could put pressure on the price of Russian pipeline gas.

The United States has interest in the region due mainly to security reasons since Greece and Turkey are part of the NATO and Israel is a key ally. It is also due to the desire to contain the increasing role and presence of Russia in the region. For the U. S., energy security is not only about energy—it's about everything around energy (Hochstein 2016). For this reason, the U.S. has considered some projects that could exclusively bring Russian gas to Europe and bypass Ukraine not only a risk to destroy opportunities for diversification but also a threat for Ukraine's economic stability and independence (Pyatt 2017). This is why, although the U.S. is essentially independent in its natural gas resources, it has expressed interest in the East Mediterranean gas resources, particularly in the development of Israel's resources (Ratner 2016). However, with the Trump administration's America first policy, the fading U.S. interest has created a political vacuum in the region, which Russia has been willing to fill with its growing presence by building friendly relations on many tracks, including energy.

Russia has tried repeatedly to establish a foothold for Russian companies in East Mediterranean gas sector by acquiring upstream assets and by participating in infrastructure or export activities. No tangible results have materialized yet in Cyprus,[27] Israel,[28] Syria,[29] Palestine[30] and Lebanon[31] but the picture is different in Egypt.[32] Russia's intention to create a southern route for Russian gas to Europe by implementing TurkStream pipeline project should not be overlooked either.[33]

[27]Russian companies Novatek and GPB Global Resources had placed bids in the second licensing round but were unsuccessful. However, the RoC is important Russia for several other reasons: it is a military foothold (since 2015, Russian navy has access to ports in Southern Cyprus), a tourism destination, and a banking hub for Russian oligarchs.

[28]In 2012, Gazprom wanted to have a stake in the Leviathan field but preference was given to Australia's Woodside. In 2013, Gazprom signed a letter of intent with the Tamar partners to export LNG, but it did not materialize. It is not clear yet whether Russian companies will express interest in Israel's offshore bidding round.

[29]A Russian state-control company still has the exploration and production license in Syria's offshore Block 2.

[30]In 2014 and 2015, Vladimir Putin discussed with Mahmoud Abbas possibilities for Russian companies to participate in Palestinian energy projects, particularly a potential Russian involvement in the Gaza Marine field, but no concrete steps have been taken yet.

[31]Three Russian companies are pre-qualified for the first licencing round.

[32]Gazprom and Rosneft began selling LNG to Egypt in 2016. Rosneft acquired a 30% stake in Zohr. By buying DEA, Russian-controlled investment fund, LetterOne, inherited a 35% share in BP's West-Nile Delta Project. Lukoil is involved in three upstream projects.

[33]In June 2017, Gazprom, Depa and Edison signed an agreement that formalizes the arrangements on expanding cooperation in the field of gas deliveries from Russia across the Black Sea to Greece and from Greece to Italy in order to set up a southern route for Russian gas to Europe. See, Gazprom press release http://www.gazprom.com/press/news/2017/june/article335060/. Accessed 18 June 2017.

What Russia really wants to achieve with all this is unclear but it is unlikely that Russia would do anything to put its market share in European market in risk. It would not be an exaggeration to argue that in the longer term it may aim to control the direction, timing and volume of gas exports from the region, especially to the markets in Europe and Turkey. When combined with Russia's escalating military and political presence, it becomes clear that energy might be a powerful tool for Russia to spread its political and economic influence in the region.

More countries and companies are likely to be involved in the region's hydrocarbon sector in the near future. The results of Lebanon's offshore licensing round, in which several Asian and Middle Eastern companies including Petropars of Iran have participated, might potentially add another layer to the future geostrategic importance of the East Mediterranean gas resources.

Last but not least, almost all the discovered hydrocarbon resources in the East Mediterranean in the last decade are natural gas with some condensate instead of oil. Any significant oil discovery in the future will surely add a new dimension to the geopolitics of the region and change the geostrategic dynamics.

12.6 Concluding Remarks

Large-scale offshore hydrocarbon discoveries since 2009 and the prospects for substantial amount of yet-to-be discovered resources in the East Mediterranean region have attracted immense international attention. However, several technical, administrative, security, legal and political obstacles have hampered the initial far-fetched ambitions and enthusiastic hype. Due to these obstacles, too much time has been wasted for launching exploration activities and for converting many discoveries into production capacity. As a consequence, various export projects have been delayed and in some cases put at risk. Formidable geopolitical challenges have also played an important role in that.

Hydrocarbon resources will be a dominant factor in the future of the East Mediterranean countries. Whether they will help promote stability, prosperity and energy security, or fuel regional and international conflict is yet to be seen. However, incompatibility of interests and expectations of the actors in the region do not provide a ground for optimism. Unless developed for the benefit of all, exploitation and transport of hydrocarbon resources may escalate confrontations and frictions, which would seriously threaten the stability and security of the region and beyond. It can also transform the region into a strategic battle ground.

The problems in the East Mediterranean, a region where geopolitics and history do matter, are unlikely to be resolved soon. If not managed carefully and wisdomly, currently pursued myopic policies by all the countries will only complicate the possibility of converting the pressing challenges the region already faces into opportunities.

There is a need to look beyond. Converging economic interests could act as a strong motivation, and perhaps a catalyst, for overcoming the differences and creating interdependencies. An informal multilateral framework bringing together the relevant stakeholders in the region could be a good start. A genuine mechanism of joint exploitation and transport of hydrocarbon resources could pave the way for establishing cooperation and collaboration, and hence potentially redraw the whole political and economic map of the region.

Politicians who lack pragmatism and use hydrocarbon resources for political gains at home are a serious obstacles to bring the prosperity of the people they represent. It is yet to be seen whether or not their commitment to populism will in the future outweigh their attachment to the welfare of their people.

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The Natural Resource Curse: A Country Case Study—Tanzania

13

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Abstract

This research aimed to uncover factors that can help developing countries with significant amounts of natural resources in avoiding the so-called 'natural resource curse'. Previous studies show mixed results; some countries show a surge in economic growth, whereas others end up with conflicts and environmental degradation, i.e. the natural resource curse. Posing local economic development and innovation as sources of national economic growth (the antithesis of the natural resource curse), this case study involved semi-structured interviews with various local stakeholders on the topic of recent natural gas findings in Tanzania. From the analysis of the interview data, a number of factors were uncovered that may lead to positive outcomes of resource exploitation and to chances to incorporate the interests of local communities. These factors include (1) *the government,* (2) *knowledge and education,* (3) *local participation,* (4) *revenues,* (5) *transparency,* (6) *legal issues, and* (7) *finance and capital*. Then, three scenarios were developed that give deeper insight into possible futures for the natural resource exploitation, using the previously identified factors. Lastly, a multi-criterion analysis (MCA) showed that the importance ranking of these factors is stable across a measure of needed change and a measure of uncertainty in the future. These seven factors then, can be seen as crucial for a successful exploitation *and* for creating opportunities for the local actor. Combining the qualitative scenario descriptions with a more quantitative MCA approach strengthens the results of this research.

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Natural resource curse · Local economic development · Innovation in developing countries

13.1 Introduction

Some country's economies seem to grow quickly after the discovery of vast amounts of natural resources, whereas others counter intuitively fall behind in their development. The so-called 'natural resource curse' has been explained by Frankel (2010, p. 1) as *"a failure of countries with abundant natural resources to grow more rapidly than those countries without"*. He argues that many countries still have low GDP per capita and a low quality of life, even though the area is rich in oil, minerals, or other natural resources (e.g. Nigeria, Sudan, and Bolivia). At the same time, countries without significant natural resources (e.g. Japan, Hong Kong, Singapore) have achieved considerable improvements in the quality of life, and have higher economic standards (Frankel 2010). Part of this resource curse is the so-called 'Dutch Disease' wherein large export revenues from natural resources cause real exchange rates to appreciate, thereby increasing prices of export goods (Bruno and Sachs 1982; Corden 1984). The name of this 'disease' has arisen from the fact that the Netherlands have experienced this effect when they first started gas exploitation around the 1960s (Corden and Neary 1982). The basic assumption was that a boom in the natural resource sector of a small country leads to real exchange appreciation, which in turn leads to deindustrialization and unemployment.

Research results regarding the natural resource curse are pointing in different directions, and there are many conflicting findings. Therefore, the question for researchers remains why natural resource abundance leads to economic success in some countries, yet to failure in others. Some countries seem to be able to avoid the negative effects of natural resource abundance (non-significant results) and in other countries the local communities are even able to benefit economically from the available resources. High (inclusive) economic growth relative to other countries, for example through local economic development and/or technological innovation, is the opposite of a resource curse. Central to these ways of achieving economic growth is the involvement of local actors and the interaction between players on the local, regional, national and international level (Pennink 2014). In short, there are conflicting findings in theory about a real-life problem that is still affecting many people today. There is thus a theoretical as well as practical urgency to study the topic, leading to the central question that this chapter has aimed to provide a first answer to: how can developing countries avoid a potential natural resource curse? More specifically, which factors can be identified, that are crucial in enabling the country to grow economically and let the citizens benefit from the exploitation of its natural resources?

In the process of this research, interview data was gathered and analyzed, resulting in a comprehensive list of factors that appear to be important in developing countries for a successful start-up of natural resource exploitation (i.e. to avoid the natural resource curse) and that ensure local involvement and benefit. Using these factors, three scenarios were constructed: a status-quo scenario, a positive scenario and a negative scenario based on previous research by Lachman (2011) and Chirozva et al. (2013). These scenarios give more insight into possible futures for Tanzania's economic development subsequent to the natural gas exploitation. Furthermore, a multi-criterion analysis (MCA) was conducted to assess the relative importance of each of the factors identified earlier. This analysis showed that seven out of the ten factors were stable across measures of uncertainty and the level of required change. Therefore, these factors can be considered 'crucial' in the exploitation of natural resources by developing countries. The seven crucial factors are: *(1) government, (2) knowledge and education, (3) local participation, (4) revenues, (5) transparency, (6) legal, and (7) finance and capital*. More research can be done in the near future to delve deeper into each of these factors, uncovering the interrelationships and the exact mechanisms that interplay in complex situations. In this chapter, we start after this introduction with a short background section and continue with a literature review. After a part in which we describe our research methodology, we present our results, and based on that we come to the conclusion and discussion.

13.2 Background

13.2.1 Tanzanian Natural Gas Discoveries

The current case study is based on recent natural gas discoveries in Tanzania. Over the past few years, there have been several offshore findings in the southern part of Tanzania, deep in the sea, with the expectation of more discoveries soon (Poncian 2014). These reserves are of such considerable size (estimations are around 55 trillion cubic feet, and expected to rise further), that if exploited, could make Tanzania one of the richest countries in terms of gas reserves worldwide (Statoil, Annual reports 2015). Smaller gas discoveries have been made on land several years ago, and some gas was produced in the Mtwara and Lindi regions, and transported to Dar Es Salaam for the generation of electricity. The country is now at the point where major decisions need to be taken regarding the second exploitation phase of the offshore gas. Currently, multinational oil companies (MOCs) such as Shell, BP and Exxon are lined up to start the second exploration phase of the potential gas fields in the deep sea, and some have already started last year.

A risk assessment by Ernst and Young (2015) shows three areas in which a high risk of doing business is perceived; legislative, taxation, and operations. For this exploration phase, most of the contracts have been signed already under the previous "Petroleum (Exploration and Production) Act 1980". However, this law was no longer suitable for the upcoming large-scale exploitation of natural gas in Tanzania. The Tanzanian government feared that foreign MOCs will not only facilitate the set-up of a new industry, but will also take the profits to the Western world once the second exploitation phase is reached. This happened in the 1990s, when large foreign firms exploited the Tanzanian gold and diamond mines, and the local citizens profited very little (Kitula 2006). Today still, human rights organizations are alarmed by the use of hazardous methods, and even child labour against very low wages in the remaining small-scale mines (Human Rights Watch 2013).

13.2.2 Exploitation Process

In Tanzania, on-land gas is relatively much easier to extract from the ground and can usually be transported via pipelines. However, with deep-sea natural gas, there are two distinct options for the extraction, refinement and transportation of the gas (Demierre et al. 2015). Firstly, the natural gas can be extracted and refined so that it can be transported through pipelines for the domestic market. This option would need a lower up-front investment in terms of refinement equipment, but on the other hand, it would need substantial infrastructural investments on the mainland of Tanzania to get the natural gas to factories and households. Secondly, it is possible that after refinement, the gas will be transformed into LNG (liquefied natural gas), which will require a full LNG-plant of several so-called ‘trains’ to be built and therefore higher up-front investments. However, the liquefied gas can then subsequently be transported in large ships and sold on the existing international market, for example in India or other Asian countries that are relatively close to Tanzania and have a growing demand (Demierre et al. 2015). Long-distance transportation of gas is viable only for LNG because the volume is 600 times smaller than ‘normal’ natural gas (Thomas and Dawe 2003).

The trade-off between the aforementioned options is extremely complex and the technical details of liquefaction of gas are beyond the scope of this chapter. Nevertheless, making the distinction is important because the choice between these options will likely have a very different effect on the Tanzanian economy. If the gas is sold on the domestic market, this would mean that an increasing number of households will gain access to gas, and possibly electricity. On the other hand, if the gas were to be sold on the international market, this would mean that the Tanzanian government could collect tax revenues from the foreign operations, which could in turn be used for further economic development. However, the success would then depend on the effectiveness and efficiency of the national government in allocating these revenues to enhance local and national economic development. Currently, the Tanzanian government is planning to set up a transparent Gas Revenue Fund to secure correct allocation and usage of the gas revenues (Oil and Gas Review 2014).

13.2.3 Academic Relevance

Over the past few years, an increasing amount of attention in the academic field has been paid to economic and social developments in various African countries. Several studies have been conducted, focusing on the challenges in decision making (e.g. Ledesma 2013), regulation and policy (Kironde 2006), training and education (Howe 2001) and potential conflicts of interest (Ndimbwa 2013) that the governments of developing countries face. The discovery of natural gas in Tanzania may increase the amount of conflict and the need for more regulations, training, and better education. However, it can also prove to be their best chance at sustainable and significant economic development in the near future.

Although the developments regarding natural gas findings in Tanzania will form the context of this research, the aim of this chapter is to explore and uncover factors that are relevant for natural resource exploitation in which the local interest is included in developing countries in general. The relevance of this situation in Tanzania for the academic field is that it provides an opportunity to study the current developments regarding the natural gas in the theoretical field of the natural resource curse. Considering the many contradictory findings as discussed in the introduction, this case study aims to uncover previously overlooked factors that might play a role in the complex process of starting up natural resource exploitation in developing countries. This may help developing countries to avoid the natural resource curse, and instead, ensure that the local citizens benefit from the exploitation. The next section will elaborate on the theoretical foundations of the present research.

13.3 Literature Review

13.3.1 Local Economic Development and National Innovation Systems

In the introduction, the *natural resource curse* was conceptualized as a 'lack of economic growth in resource abundant countries, relative to other countries' (Frankel 2010). The opposite of a natural resource curse, then, is relatively high economic growth compared to other economies. There are several ways to stimulate this country-level economic growth, such as local economic development (LED) and innovation (Helmsing 2001; Chen and Puttitanun 2005). Helmsing (2003) has investigated the changing context of local economic development in Africa, which is mainly due to two general factors; liberalization and technological advances (i.e. innovation) in the countries. The author argues that local action as well as the involvement of the government in building institutions is an important factor in determining the economic performance of a country (Helmsing 2001). Local Economic Development can be defined as: "*a process in which partnerships between local governments, community and civic groups and the private sector are established to manage existing resources to create jobs and stimulate the economy of a well-defined area*" (Helmsing 2003, p. 69). This local economic development involving the three aforementioned parties can then lead to the strengthening of the whole national economy.

The greatest strength of Local Economic Development lies in linking economic activities to the geographical location, thus creating sustainable employment in local enterprises (Rodriguez-Pose 2001, 2009). Moreover, according to the International

Labour Organization (ILO), LED strategies involve local stakeholders, attributing to a wider range of socio-economic goals (ILO 2008). The development of a country is increasingly not only measured as economic performance, but also about sustainable development of economic, social and environmental goals (Ruecker and Trah 2007). As stated by Christensen and Van der Ree (2008), LED aims to make the most of local (natural) resources, so that it will lead to increased returns from the global market. Theoretically, LED is often seen as a ‘branch’ of regional development theory, exploring the actors, structures and processes of economic growth within a specific geographical space (Pike et al. 2006; Gomez and Helmsing 2008).

As mentioned earlier, not only Local Economic Development, but also technological innovation can be a major determinant of economic growth (e.g. Rosenberg 2004). It is argued that technical change requires knowledge, institutional structures, and technological capabilities within the industry (Archibugi and Michie 1997). In developing countries, domestic innovation can only be the engine of economic growth when these conditions are met. In terms of resource exploitation—setting up a full new industry requires a whole new body of technical knowledge—significant technological innovations (or diffusion of innovations from elsewhere) will need to take place (Kim and Nelson 2000). However, whether this technological innovation can be accomplished domestically remains to be seen. Chen and Puttitanun (2005) have argued for a balance between domestic innovation and the imitation of foreign technologies in developing countries. One issue that is important in order to create the conditions conducive to domestic innovation is intellectual property rights (IPRs). The authors argue that at the optimal level of IPR—with the right mix of domestic and foreign innovation—the GDP in developing countries will be the highest (Chen and Puttitanun 2005). Balancing foreign and domestic innovations can thus lead to an increase in GDP in developing countries.

Regarding domestic innovation, the national innovation system of the country determines the direction and rate of the innovations that can be created within such a system. This system includes the relationship between organizations, institutions, and socio-economic structures (Lundvall et al. 2011). O’Doherty and Arnold (2003) described the national innovation system as depending for a large part on the interactions between universities and the industry, which in turn are affected by politics, market demand, and the general infrastructure in the country. It is important to note that the innovation system in a developing country may not be fully developed, hampering the rate of domestic innovations that can be achieved.

Pennink (2014) devised a model to connect the set-up of local economic activities with different economic levels. On the national level, he argues for the importance of the interaction between government, universities and business for LED, which is also called the Triple Helix Model (Pennink 2014). This is very similar to the interactions in national innovation systems (i.e. the relationships between universities and the industry, which are affected by politics). In a way, these same interactions then influence both the opportunities for LED and domestic innovation, which are essential drivers of economic growth. Studying these three groups of stakeholders as: *“any group or individual that the firm needs in order to exist, who can affect or is affected by the achievement of an organization’s objectives”*

(Freeman 1984, p. 46) then seems a logical next step in this research, while focusing on avoiding the natural resource curse in developing countries.

13.3.2 Research Question

Linking the theory of local economic development and national innovation systems back to the question raised at the end of the introduction—i.e. how can developing countries avoid the natural resource curse?—several connections become apparent. As mentioned earlier, economic growth (through LED and a balance between domestic and foreign innovations) seems to be the opposite of a natural resource curse. An abundance of natural resources may lead to accelerated economic growth, but can also be a 'curse' in the sense that economic growth lags behind and the environment suffers from the exploitation (e.g. Sachs and Warner 2001; Wright and Czelusta 2003). Also, as shown by Pennink (2014) and O'Doherty and Arnold (2003), the three interacting stakeholder groups (more specifically, the government, universities, and the industry) are extremely important in creating economic growth through both LED and innovation. These three groups also form the Triple Helix model (Pennink 2014), which fuels the motor of economic development.

Therefore, it will be an interesting research path to analyze the recent developments in Tanzania by interviewing members of the different stakeholder groups mentioned earlier on the natural resource curse; why do some countries prosper, while other countries fail in the situation where natural resources are abundant? This leads to the following main research question**:** *How can the natural resource curse be avoided in the start-up of natural resource exploitation in developing countries?*

This main research question is divided into the following three sub-questions:

(a) *Which factors can be identified, that influence the start-up phase of the natural resource exploitation positively or negatively?*
(b) *What role will these factors play in a status-quo, positive-but-plausible, and negative-but-plausible scenario for the natural resource exploitation?*
(c) *Which of the identified factors from question a) are crucial for achieving success, and avoiding failure, of the natural resource exploitation?*

The first sub-question will be answered through semi-structured interviews, and the second sub-question will be answered through combining the different scenario descriptions from each interview into three short narratives. The third sub-question will be answered by performing a multi-criteria analysis on the identified factors from sub-question a. In sub-question c, the concept of success is operationalized in terms of inclusive economic growth, where local citizens in Tanzania also benefit from the exploitation. In short, this chapter aims to uncover from different points of view (i.e. the interests of three different stakeholder groups; government, the industry, and universities), which factors they identify in the start-up of natural resource exploitation, that could lead to economic success or failure of the exploitation and in which way the focus on the local development could be included in looking for these factors.

13.4 Methodology

Tanzania was chosen as case for this research because it gives the opportunity to study current developments regarding the resource exploitation; i.e. it allows for studying the factors that might influence the start-up process of this exploitation. In terms of theoretical sampling (Yin 2009) Tanzania is a developing country with relatively high political stability and stable economic growth, but with considerable differences in wealth. In this setting a promising amount of natural gas has been found. So, the question is, will revenues mostly go to the international market or also (partly) to the local market where these revenues are badly needed to improve the overall position of the people in Tanzania. In this way, this case has unique aspects in terms of natural resources, economic growth, and stability.

The research involves multiple ways of data collection and analysis (Denzin and Lincoln 2009). The research process can be characterized as sequential academic problem-solution, each step following from the data gathered in the previous steps (van Aken et al. 2012). This was achieved through multiple rounds of interviewing. Van Aken et al. (2012) also argue in favour of a conceptual project design, which is an initial outline of the project that may be adapted as insights evolve during the research process. For this chapter, the choice was made to focus on the aspect of engaging three core stakeholder groups (i.e. government, industry, and universities) to discover crucial factors for the future economic development in developing countries, after the discovery of natural resources. As a consequence of this focus, our research design made use of qualitative research strategies. The choice for the three specific groups was made based on previous research by Pennink (2014) and O'Doherty and Arnold (2003) as the interactions between these three groups form the basis of economic growth through *Local* Economic Development and *domestic* innovation.

13.4.1 Data Collection

The data collection process of this research consisted of several steps. First, a round of desk research was performed, accompanied by preliminary interviews in the Netherlands, to gain background knowledge on the topic and to understand the different actors involved. Second, a round of individual interviews was performed in Tanzania, during the period of 21 August–17 September 2015. The interviews were held with individuals from the three different stakeholder groups indicated earlier. Consequently, the sampling method was non-probabilistic because members of these three specific groups were contacted purposely. Bryman (2004) argues that this method is justified and the validity of the results is assured, as this sampling method is more likely to deliver results relevant to the main research question.

Table 13.1 Data collection overview

	Location	Collected data	Short description
Round 1	Netherlands	2 Interviews	Preliminary interviews to gain background information before traveling to Tanzania
Round 2	Tanzania	5 Interviews	Semi-structured interviews aimed at answering the main research question
Round 3	Netherlands	1 Interview	Expert interview to check generalizability and validity of the research findings

Including local residents and various interest groups is also found to increase analytical breadth, robustness of results, and legitimacy of the findings of academic studies (e.g. Fiorino 1989; Bohman 1996). The final data collection consisted of two preliminary interviews in the Netherlands, five main interviews, and one final expert interview back in the Netherlands (Table 13.1). Consequently, the total number of interviews was limited eight, which is due to several factors, among which the difficulty to reach people willing to be interviewed, and the time frame in which this research was executed. This will be elucidated in the limitations section. The data collection thus took place in three different rounds. Due to the promise of anonymous data collection, the names of the interviewees are to remain confidential. However, the interviewees are from a range of companies and other organizations including the Tanzanian government, oil and gas companies, NGOs (Non-Governmental Organizations), the University of Dar Es Salaam and the Dutch Embassy in Tanzania.

This research contained three rounds of data collection. The preliminary interviews were aimed at getting background information before travelling to Tanzania, whereas the main interviews had the purpose of uncovering the visions and interests of each individual. The five main interviews provided a substantial amount of data, so that the final interview barely revealed any new information—and although the number of interviews was limited, it seemed that the so-called saturation point was reached nonetheless (Corbin and Strauss 1990). Finally, one last expert interview was held to verify if the gathered data and preliminary results were applicable on a broader scale than the situation in Tanzania. The main interview questions were largely based on the research by Lachman (2011) on energy scenarios and strategies in Suriname. All main interviews were taped and transcribed, to be able to repeatedly go back to the conversation during data analysis.

13.4.2 Data Analysis

Two distinct methods are used in this case study to analyse the interview data gathered; *scenario building* and *multi-criteria analysis*. Combining different data sources and analysis methods leads to multiple steps in the data analysis and increases validity of the findings. The validity of this research was increased through triangulation; using multiple methods and data sources in the study of one phenomenon (Denzin 1978).

13.4.2.1 Constructing Factors and Scenarios

The first steps of the data analysis focused on discovering the various factors mentioned by the interviewees, and trying to group these into broader concepts in a coding process. Then, the uncovered 'higher-order' factors were implemented into several possible futures for the economic development arising from the natural resource exploitation. More specifically, following Lachman (2011) and Chirozva et al. (2013), three scenarios were constructed with the help of the factors that were constructed based on the interview results; (1) a status-quo scenario in which the current practices are continued, (2) a 'positive-yet-plausible' scenario, and (3) a 'negative-yet-plausible' scenario. The factors were also implemented into each scenario (Lachman 2011). Ultimately, these scenarios aim to gain deeper insight into the factors that play a role in the natural resource exploitation in Tanzania, and which factors would contribute to a better or worse outcome in the economic future of the country. The factors and scenarios will be described in the results section.

13.4.2.2 Multi-criteria Analysis

Next to qualitative interview data, the second part of the questions in the interview guide about ranking the factors were input for the multi-criteria analysis (MCA) that has been performed. MCA is an appraisal method that is widely used to assess options based on several criteria, and then, according to a mathematical formula, calculate rankings of these options (Kowalski et al. 2009). In other words, seeing the three scenarios as different 'options' for the future, this analysis allows for meaningful comparison, but also based on mathematical calculations. The MCA techniques are widely used in the research field of energy, which makes it especially applicable in this research. The main difference between MCA and conventional risk assessment is that not one single course of action is examined, rather the starting point is a range of different options, and a relative performance ranking of these options is sought (Stirling and Mayer 1999). The added value of the MCA is that it allows for insight into how the different factors are currently scoring in terms of development (i.e. Is a factor currently very weak with a score of one, or average with a score of three?), which factors need rapid or considerable improvement, and which ones require less drastic changes to arrive in a positive scenario. This gives the results of this research a more quantitative dimension, thereby increasing the objectivity of the findings and the quality of the overall study. The MCA will focus on two specific characteristics of the factors: the uncertainty and the level of change required (based on Lachman 2011).

13.5 Results

13.5.1 Identifying Factors

Table 13.2 shows ten factors that were identified through the interviews in this research. Many of these were mentioned repeatedly in multiple interviews. Because the interviewees were from different backgrounds and professions, this is an early

Table 13.2 Overview of factors

Factor tanking	Overall name	Mentioned in interviews as...
1	Knowledge and education	Knowledge; knowhow: Human resources and expertise; citizen's information access; education
2	Government	Non-corrupt stable government; government capacity; oversight; capacity of industry agencies (regulatory)
3	Legal	Legal framework; legislation; law enforcement
4	Contracts	Current contracts; future contracts
5	Revenues	Revenue allocation; revenue fund
6	Local participation	Participation of local companies; knowledge transfer to local companies
7	Transparency	Transparent value chain; transparency; accountability
8	Finance and capital	Finance; capital
9	Land	Land issues
10	Standards	Quality of industry standards

indication that the dataset is comprehensive and that the mentioned factors are indeed relevant across multiple stakeholder groups. The factors are ranked from one to 10 based on how many times they were mentioned (accumulated) throughout the interviews.

13.5.2 Scenario Building

With these factors in mind and the scenario descriptions derived from the interviews, three scenarios were written. This has resulted in three short narratives, inspired by the interview data and background information gathered prior to, and during the visit to Tanzania. The choice for a 'current', 'positive-yet-plausible' and 'negative-yet-plausible' scenario was made based on research by Lachman (2011) and Chirozva et al. (2013). The previously discussed factors are mentioned in the scenarios when relevant (in *italics*), however there is no direct relation between each individual factor and one specific scenario, as these were separate interview questions. Some interviewees mentioned the same factors to be important in the scenarios whereas others came up with a more descriptive answer to the scenario questions. Several factors are mentioned in multiple scenarios, indicating importance for the future Tanzanian economy and benefit of local citizens.

13.5.2.1 Current Scenario (Status-Quo)

First, the interviewees were asked to describe their view of the current scenario in Tanzania. Elements considered important in the current scenario included considerable uncertainty about the future location of the LNG plant (*land*), the recently implemented laws that have not been tested adequately yet (*legal; government*), and a lack of transparency regarding the product-sharing agreements between the government and foreign oil and gas companies (*transparency*). On the other hand, positive signs are also seen with the first investors starting to operate in Tanzania, as well as several educational and vocational trainings being issued across the country (*knowledge and education*). Efforts are also made to assure better information access for citizens about natural gas, and how it can add value to benefit the citizens, and plans are made for a revenue fund (*revenues*). From the conference, it became clear that there is a considerable number of companies willing to invest in the country (*finance and capital*). For the near future, this would mean that investors may start the first big projects in Tanzania, thereby helping the country's economic development. So, the current scenario shows mixed signs of positive aspects, and other issues that are still cause for some concern.

13.5.2.2 Positive-Yet-Plausible Scenario

Secondly, the question was raised how the interviewees perceived a positive, but realistic outlook on the near future of natural resource exploitation in Tanzania. First, it was mentioned that the FID (Final Investment Decision) would be made soon in the positive scenario, as that would mean the whole process of building the facilities to extract the gas and to transform and/or transport it elsewhere could be started (*land; contracts*). Also, the importance of fully implementing the new laws (*legal; government*), and increased accountability and transparency (*transparency*) were mentioned to be important in assuring a positive outcome for the natural gas exploitation. Considerable investments would be made across several sectors (*finance and capital*), and education and entrepreneurship programs would be important to further develop the country and the expertise of local citizens (*knowledge and education*). The revenues from the gas exploitation would be allocated to a revenue fund, and be spent wisely on projects that help the further economic development of the country by the government (*revenues; government*). Lastly, the specific and high-tech knowledge of the foreign companies would be transferred to locals in the positive scenario (*local participation*), so that the Tanzanians could run the entire extraction and exploitation process by themselves in the more distant future.

13.5.2.3 Negative-Yet-Plausible Scenario

Lastly, the interviewees were asked to construct a scenario that was negative, but plausible for the future exploitation of resources in Tanzania. One interviewee described the situation where exploitation would be started 'too soon', i.e. when the country was not ready in terms of institutions, legislation, infrastructure, and so on (*legal; government*). This would be bad because it would leave room for corruption. The term corruption was also mentioned in another interview as reducing the amount of money available to develop the country and improve the life of the citizens. It diminishes the chance that the revenues from the gas can be used to improve the current conditions in the country (*revenues*). Also, a bad implementation of new laws and a lack of knowledge about gas exploitation were mentioned to be negative aspects (*knowledge and education*), as these may lead to conflicts within the country. Finally, loopholes in contracts were mentioned to limit the degree to which Tanzania can assure revenues from the gas exploitation (*contracts*), as multinational companies can benefit from their superior legal knowledge and their experience with drawing up contracts.

13.5.3 Crucial Factors

The multi-criteria analysis was based on the rankings that each interviewee has given to the different factors (i.e. which is the most important one, number two, and so on) and the score of between one and five on a Likert scale that was given under each scenario. This resulted in a performance score for each scenario and allowed for comparisons on the factor level. As mentioned earlier, the first sub-research question (a) was about which factors could be found in the data. After writing the scenarios (sub-question b), the MCA was used to determine which of these factors are critical (i.e. to answer sub-question c). Earlier research by Lachman (2011) has ranked crucial factors based on two characteristics: level of required change and degree of uncertainty. In other words, the factors are the most critical when both the required change and the uncertainty are high. The MCA allows for a comparison of the different factors on these two characteristics.

The number of interviews in which a factor was mentioned, corresponds to the assigned weights to each factor. Then, this was combined with the scores that were given on the ranking scheme for each factor. The total scores for each scenario (see Appendix) are not surprising as the positive scenario was designed to score better than the negative scenario, however it is interesting to consider the differences between the negative and positive score of each factor (this indicates the relative uncertainty of the concerned factor). Moreover, the difference in average score between the positive and the current outcome indicates the level of change that is needed on that aspect to help Tanzania (or another developing country) avoid the natural resource curse. These differential scores can be found in the two final columns of the table in the Appendix on page 19. Table 13.3 above ranks the factors with relatively the highest uncertainty (column 1), and those requiring the highest level of change (column 2).

It quickly becomes apparent that the first seven factors are the same for both rankings. This is interesting, because it means that the same areas or factors that are perceived to be relatively uncertain (or volatile) for the future are also the ones that require the biggest change to be successful. On the one hand this would seem a ‘logical’ conclusion, however it does indicate that the critical factors need to be improved carefully and with great effort to make sure that the natural resources benefit the country and the citizens of Tanzania. These seven factors can be labeled the ‘crucial’ factors for avoiding the natural resource curse and overcoming the rentier state as described by the rentier state theory (Almaz 2015). In this context, we mean by rentier state a country that generates income by selling the natural resources on the world market and not by stimulating economic activities in the country, and as a consequence, low or hardly economic and social development in the country. Paying explicit attention to the crucial factors could contribute in overcoming the

Table 13.3 Factor ranking overview

	Factors (ranking based on level of uncertainty—difference between max and min score)	Factors (ranking based on level of change required—difference between current and max score)
1	Government	Government
2	Knowledge and education	Knowledge and education
3	Local participation	Local participation
4	Revenues	Revenues
5	Transparency	Transparency
6	Legal	Legal
7	Finance and capital	Finance and capital
8	*Contracts*	*Standards*
9	*Standards*	*Land*
10	*Land*	*Contracts*

dangers for Tanzania of becoming a rentier state. The local people will be supported by improving their knowledge and education and can give them a voice in these discussions. Besides that, clear legal arrangements and transparency must be developed. All factors will contribute to the development of democracy and will limit the power of a small national government or elite.

13.6 Conclusion and Discussion

13.6.1 Conclusion

This chapter aimed to answer the question *"How can the natural resource curse be avoided in the start-up of natural resource exploitation in developing countries?"*. Several rounds of data collection provided data both in the Netherlands and in Tanzania. Then, the interview data was analyzed, rewritten into scenarios, and finally a multi-criteria analysis has yielded seven crucial factors. The factors that have shown to be the most critical to the success of the natural resource exploitation according to the MCA are: (1) *the government* (i.e. stable, non-corrupt, capacity), (2) *knowledge and education* (i.e. know-how, human resources, information access), (3) *local participation* (i.e. local companies take part in the value chain, transfer of knowledge to local firms), (4) *revenues* (i.e. the allocation and the use of the planned revenue fund), (5) *transparency* (i.e. within the value chain and clear accountability), (6) *legal* aspects (i.e. regulations and enforcement of the law), (7) *finance and capital* (i.e. finance, investments and capital). The scenario descriptions have given more insight into what role these factors might play in different possible futures for Tanzania. The critical factors that were uncovered in this research will need a lot of effort and work to make sure that Tanzania, or other developing countries, can benefit from natural resource exploitation, and to make sure that inclusive economic growth (beneficial for the locals) results from it. Keeping these factors in mind can help the government and other stakeholders to focus on the earnest issues to avoid the natural resource curse.

In the introduction and literature review, frequent references have been made to two distinct drivers of economic growth; innovation and local economic development. Looking at the factors resulting from this research, *local participation* and *information access for citizens* (part of the knowledge and education factor) are relevant for LED, but no direct links to innovation (either foreign or domestic) can be found. One explanation for this would be that the national innovation system of Tanzania is currently not strong enough to conduct domestic innovation. Improvement on the crucial factors from this research may lead to an investment and general business climate that is more conducive to domestic innovation, in turn leading to further economic development and welfare for the citizens. Another explanation could be that there is not enough knowledge available to people to start thinking about the potential role that domestic innovation could bring to the country. This is also an interesting path for future research, delving deeper into the potential for innovation in developing countries.

13.6.2 Implications

Looking back to the theoretical field, this chapter has made a first attempt to identify factors that may have been overlooked in previous research, which might help developing countries in avoiding the resource curse. Inconsistent findings in the academic field prompted this research. Further research will be needed to determine on a more quantitative basis which factors have the most significant contribution to the goals of economic development and domestic innovation. The factors that were identified are applicable on a broader basis than just case in Tanzania; by grouping the specific terms mentioned in the interviews into broader factor concepts, the results of this research are also interesting for policy makers, researchers, and practitioners in other locations. Based on the findings of this research, although it is realized that this is based on a small sample size, the following proposition can be formulated, that may be used for quantitative research in further studies: *"Taking into account (1) the government, (2) knowledge and education, (3) local participation, (4) revenues, (5) transparency, (6) legal issues, and (7) finance and capital, will decrease the chance that a developing country suffers from a natural resource curse, and increases the opportunities for inclusive economic growth for that same country."*

13.6.3 Limitations and Future Research

As with any academic study, the current research has several limitations that should be acknowledged here. First, there is the issue of the sample selection and sample size. Due to time constraints and communication difficulties (i.e. lack of internet access during the field study and often no other contacting possibilities) the sample size is rather small, although as explained earlier, it seems that the dataset is quite saturated in terms of new information. The sample selection is purposive and therefore, generalizability is limited. Although the specific formulations from the interviews and scenario descriptions are limited in generalizability to the Tanzanian case study, the general factors seem to be applicable in a wider context (i.e. other developing countries facing natural resource exploitation). This proposition may be tested in future research by focusing on one or more factors at a time, thereby giving the current preliminary findings a quantitative and larger-scale body of evidence. Also, collecting data in other locations and with wider time-frames will expand the generalizability of the current preliminary results.

Another difficulty encountered in this research was one of doing research abroad, in a country with a very different culture, language, traditions, and economic and social development stage. Also, there was a limited time frame of the travels (4 weeks). A longer data collection period could have resulted in more interviews. Still, the current research has been carried out to the best abilities of the researcher, and has included multiple methods and efforts to aim for interesting and high-quality results. It is hoped that this research can be used for further studies into the natural resource curse in developing countries and that it is a useful and interesting addition to the academic field.

Appendix

Scenario scores from Multi-criteria analysis

Factors	Weight	Current scenario Total score per factor	Positive scenario Total score per factor	Negative scenario Total score per factor	Max–Min	Max–Current
1. Knowledge and education	4	7	15	6	9	8
2. Government	4	9.5	18	6	12	8.5
3. Legal	3	9	13.5	7.5	6	4.5
4. Contracts	2	7	8	4	4	1
5. Revenues	2	2	8.5	2	6.5	6.5
6. Local participation	2	3	10	2.5	7.5	7
7. Transparency	2	3	8	2	6	5
8. Finance and capital	2	5	9	4	5	4
9. Land	1	2	4	2	2	2
10. Standards	1	1	4.5	1	3.5	3.5
Total score per scenario	–	**48.5**	**98.5**	**37**	–	–

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